NPS 68-79-003

NAVAL POSTGRADUATE SCHOOL

Monterey, California

The Oceanographic Cruise of the USCGC GLACIER
to the Marginal Sea-Ice Zone of the Chukchi Sea --
MIZPAC 78

Robert G. Paquette and Robert H. Bourke

May 1979

Interim Report for Period July 1978 - May 1979

Approved for public release; distribution unlimited

Prepared for:
Director, Arctic Submarine Laboratory
Naval Ocean Systems Center
San Diego, CA 92152

NAVAL POSTGRADUATE SCHOOL
Monterey, California

The work reported herein was supported in part by the Arctic Submarine Laboratory, Naval Ocean Systems Center, San Diego, California under Project Order Nos. 00002 and 00004.

This report was prepared bv:

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER NPS 68-79-003	2. GOVT ACCESSION NO.
	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) The Oceanographic Cruise of the USCGC GLACIER to the Marginal Sea-Ice Zone of the Chukchi Sea--MIZPAC 78	5. TYPE OF REPORT & PERIOD COVERED Interim 14 July 1978-2 May 1979
	6. PERFORMING ORG. REPORT NUMBER NPS 68-79-003
7. AUTHOR(s) Robert G. Paquette and Robert H. Bourke	8. CONTRACT OR GRANT NUMBER(s) N66001-78-PO-00002 N66001-79-PO-00004
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Postgraduate School Monterey, CA 93940	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS Element:62758N;WorK:MR01549A09 Project: ZF52-555 Task: ZF52-555-001
11. CONTROLLING OFFICE NAME AND ADDRESS Arctic Submarine Laboratory Code 54, Bldg 371, Naval Ocean System Center San Diego, CA 92152	12. REPORT DATE May 1979
	13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report) UNCLASS
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Marginal Sea-Ice Zone
Thermal Finestructure
Chukchi Sea
Arctic Ocean
MIZPAC
CTD
Salinity Spiking
Oceanography
Fronts
Microstructure

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report presents the data and briefly describes the oceanographic results of the cruise of the USCGC GLACIER to the marginal sea-ice zone of the Chukchi Sea during the period 14 to 28 July 1978. A brief analysis is presented which shows yearly recurring ice bays presumed to be due to bathymetric steering of warm currents. The relationship of upper and lower level temperature fronts to each other and their association with temperature finestructure is described. Plots of temperature, salinity, density (σ_t)

and sound speed are presented for each station. A detailed discussion of salinity spike removal and data editing routines changed since the last report is presented in Appendix A.

TABLE OF CONTENTS

LIST OF FIGURES

THE OCEANOGRAPHIC CRUISE OF USCGC GLACIER TO THE MARGINAL SEA-ICE ZONE OF THE CHUKCHI SEA - MIZPAC 78

by

Robert G. Paquette and Robert H. Bourke
Naval Postgraduate School, Monterey, CA 93940

I. INTRODUCTION

This report presents the data and briefly describes the oceanographic results of the cruise of USCGC GLACIER into the region of the sea-ice margin of the Chukchi Sea during the period 14 July to 28 July 1978 as part of the program designated MIZPAC 78. The primary objective of the cruise was to find and characterize finestructure in the vertical temperature profiles and to discover its horizontal distribution and causes. This is the sixth cruise devoted to this general problem. Other cruises in 1971, 1972, and 1974 were reported by Paquette and Bourke (1973, 1976), 1975 by Zuberbuhler and Roeder (1976), and 1977 by Graham (1978) and Paquette and Bourke (1978). An analysis of the MIZPAC 78 data has been performed by Small (1979).

II. GENERAL DISCUSSION

The scientific group boarded GLACIER at Nome, Alaska by helicopter on 14 July. The scientists and their affiliations were:

Dr. John Newton, Naval Ocean Systems Center, Chief Scientist
Dr. Robert G. Paquette, Naval Postgraduate School (NPS)
Dr. Robert H. Bourke, NPS
LT W. R. Lohrman, USN, Student at NPS
LT W. E. Small, USN, Student at NPS
LT P. Padilla, Ecuadorian Navy, Student at NPS

The measurements made were salinity and temperature profiles throughout the entire water column at 130 stations, using the Applied Physics Laboratory-University of Washington (APL-UW) portable, hand-lowered CTD. One hundred and six stations were occupied from the drifting ship while 24 lowerings were made from a hovering helicopter. The helicopter lowerings were a useful adjunct as they could be used to extend survey lines relatively quickly. They were especially useful in the ice where reduced icebreaker speed would have caused delays. However, the helicopter is so restricted to periods of good visibility that it is difficult to plan its use. Also, only four stations typically can be occuppied during one flight. The lowering rate of the CTD from the ship was about 1m sec^{-1} resulting in a data rate of approximately three points per meter. Lowering from the helicopter was usually faster.

The CTD was checked systematically with Nansen bottles lowered on a second wire. Prior to leaving each station, the temperature and salinity were plotted utilizing a Hewlett-Packard 9100 series computer/plotter system. These rough plots were used to make immediate assessments of the presence of finestructure and to aid in the decision of where to make the next few stations. They also became valuable when it was later discovered that due to a variety of problems some digital data could not be recovered from the cassette tapes. Cross-sections of temperature were constructed along transects normal and parallel to the ice front to aid in the identification of fronts.

Navigation was by visual piloting and radar when within range of land. The navigation satellite system was the principal position locater when well away from land, but due to equipment malfunctions most station positions were determined by the Omega system, considered to have an accuracy in these waters of $\pm$ 5 km.

Current measurements were intended to be made for periods up to an hour using a Savonius type meter moored just above the sea floor and with the ice breaker lying to in the near vicinity. This procedure was adopted due to previous experience wherein over-the-side measurements were rendered nearly useless due to deviation of the magnetic direction sensor by the ship's iron. However, due to poor seamanship, the initial attempt at mooring the current meter caused it to be fouled in the screws. The meter was recovered but the prospect of continuing so risky and time-consuming an operation appeared unprofitable and no further moorings were made.

Dissolved oxygen and gas samples for carbon dioxide and methane were drawn at three stations: outside the ice, in a region of intense finestructure, and behind the ice. Samples were drawn from depths above, below, and within a lens of temperature finestructure. The gas samples were analyzed through the courtesy of Dr. John Kelley of the Naval Arctic Research Laboratory. Neither the oxygen nor the gas samples revealed any salient features characteristic of finestructure activity. If there is a correlation, much more intensive sampling would be required to demonstrate it.

The original cruise plan was oriented toward sampling in the relatively unstudied western Chukchi Sea. However, denial of permission to go west of the Treaty Line forced a last-minute change of plans to one similar to MIZPAC 77. More emphasis now was to be put on phenomena in the ice bays and near the branches of current streams to attempt to confirm the hypotheses regarding fronts expressed in Graham (1978).

The first half of the cruise proceeded routinely, concentrating on measurements in and near the large western embayment seen in Figure 1. Observations had to be terminated after Station 58 when the ship had to

depart for Barrow to pick up engine spares. The ship had been limited to operations on one or two engines from the outset. From 23 July onward the ship operated in close proximity to Barrow, again mostly on one engine. Subject to these constraints, ice margin crossings and transects of the Alaskan Coastal Current were made, avoiding areas of moderate to heavy ice conditions.

III. DATA

The CTD was standardized by means of a Nansen bottle lowered on a second wire to a depth just above the sea floor. Fourty four such comparisons were in sufficiently unchanging water for temperature standardization and 40 for salinity. Two CTD systems were employed; their error statistics are shown in the following table:

	Temperature	Salinity
Mean Error (Nansen-CTD)		
CTD #3	-0.012°C	+0.007‰
CTD #4	-0.045°C	-0.007‰
Standard Deviation		
CTD #3	±0.0140°C	±0.0184‰
CTD #4	±0.0358°C	±0.0204‰

The CTD records its data on a cassette which is eventually transferred to a seven-track tape by APL-UW for data editing and analysis at NPS. Modifications required this year to the computerized editing routine, described in some detail in the MIZPAC 77 report (Paquette and Bourke, 1978), are presented in Appendix A. Noise problems were considerably more significant and complex this year requiring a modification of the noise removal subroutine. Also, the despiking subroutine was altered to make it more logical, as indicated in Appendix A.

Heading data for each station are listed in Appendix C. These contain station position and number, date/time of CTD lowering, water depth, type of navigation, wind, wave, and air temperature data, etc. Appendix B is an explanation of the codes used in Appendix C.

Plotting routines were used to display property profiles for each station: temperature, salinity, sound speed, and density (σ_t). These are compactly plotted four stations per page and displayed in Appendix D. Stations taken in the deep water of the Barrow Canyon are shown two per page. The helicopter stations are plotted separately at the end of Appendix D. Plots of 4 stations do not appear in Appendix D, but their property profiles are available from the original "at sea" plots. Due to sensor malfunctions the data from five helicopter stations were unrecoverable.

IV. RESULTS

The array of stations occupied is shown in Figure 1 together with an ice-margin position based principally upon observations made at the times stations were occupied. The ice-margin is thus not a single synoptic view,

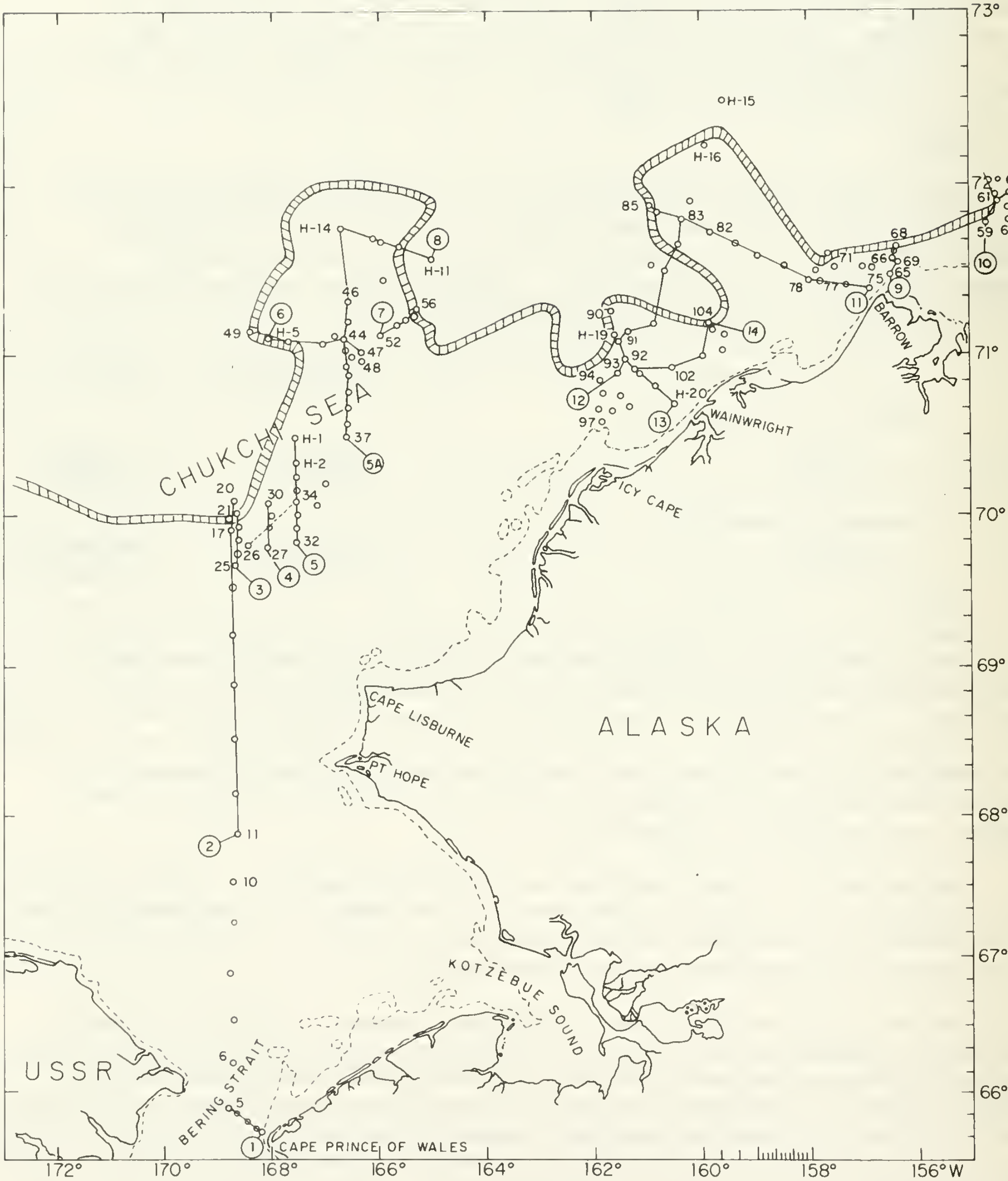


Figure 1. Station plot of MIZPAC 78. The position of the ice margin at the time of observation is also shown. The location of temperature-salinity cross-sections constructed by Small (1979) are indicated by the solid lines between stations. Only Crossing No. 2 is shown in this report.

but a progressively distorted one which is more useful in describing ice-related phenomena. Synoptic views are also available. Figure 2 is a computer-drawn, expanded view of the cruise track partitioned into an eastern and a western section. Figure 1, taken from Small (1979) also shows transects for which temperature and salinity cross-sections have been constructed. Only Crossing 2 is shown in this report.

As seen in Figure 3, Crossing 2 cuts across the warm current branch that flows northwestward to Herald Canyon. The warm water of the central Chukchi is isolated from the colder waters below by an extremely sharp thermocline, of the order of 5° to 7° C/m. The warm water extends within 5 km of the ice causing a sharp upper-layer front to be formed in both temperature and salinity. Because the warm water from the south is the principal agent in melting the ice, an upper-layer front close to the ice is a widespread phenomenon of the MIZ.

Even more striking in Figure 3 is the lower-layer front, coincident or nearly so with the upper-layer front. This frontal situation has also been observed in 1975 and 1977 in almost the same geographic position and ice edge pattern. Although four coincident fronts were found in MIZPAC 78, these have been rarely observed on other cruises perhaps because we did not sample in the areas conducive to their formation. All of these coincident fronts are associated with regions of slow ice-edge recession where the upper and lower-layer currents from the south are assumed to flow more or less parallel to the ice edge and the lateral current shear to erode away the cold, relict under-ice water which otherwise would extend out beyond the ice edge. Other coincident fronts were observed at Crossings 8, 9, and 14 (Figure 1). Contrary to previous findings, finestructure is found south of this coincident front but at such large distances from the ice as to suggest some other cause than simple interleaving of transition water and northern bottom water.

The large ice embayment seen in Figure 1 centered at 166° W is an annual feature observed in all the MIZPAC cruises. Figure 4 and Crossings 5 through 8 indicate that the embayment is melted out by a jet-like core of warm water. The current pattern of Figure 4 has been derived from the ice melt-back pattern and the sea floor bathymetry. Because this embayment recurs year after year in nearly the same geographic position, we believe that bathymetric steering of the warm southern water down the 25 fathom trough must account for its formation. In addition to the western embayment, other examples of bathymetric steering are evident. The ice melt-back pattern and temperature cross-sections indicate that the Alaskan Coastal Current bifurcates at topographic junctures (Figure 4) to cause the large embayment northwest of Barrow and the smaller embayment west of Wainwright.

This was the first year that observations were taken within the embayment; previously we had tended to sample along its periphery. Figure 5, which shows the distribution of finestructure coded according to Table 1, indicates rather large areas of moderate to strong finestructure. An example of this finestructure is shown in Figure 6 as nested temperature profiles taken along the axis of the embayment. These and all other finestructure areas were located in the region of transition water between the northern and southern bottom water.

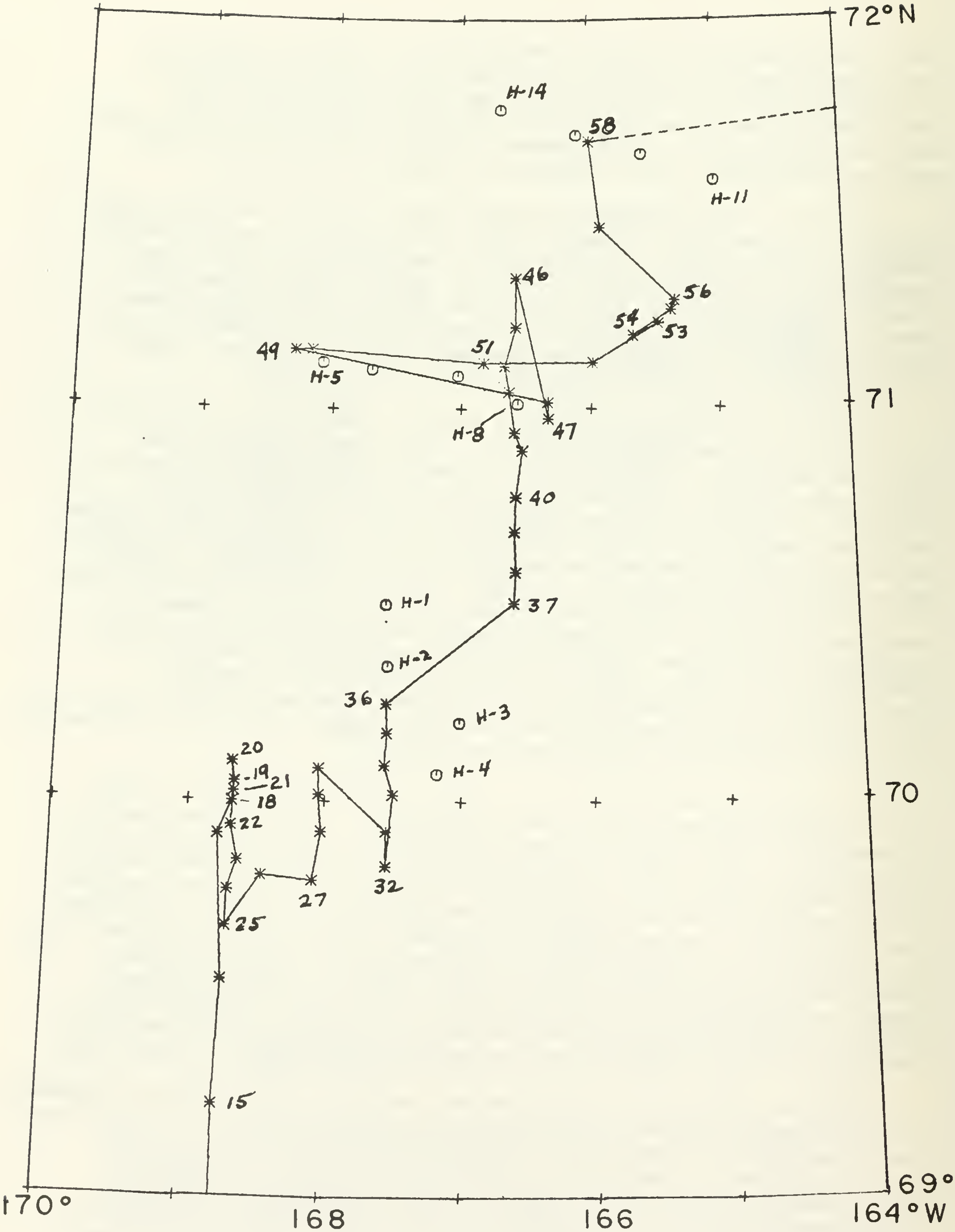


Figure 2A. Computer-drawn, expanded-scale station plot of MIZPAC 78.

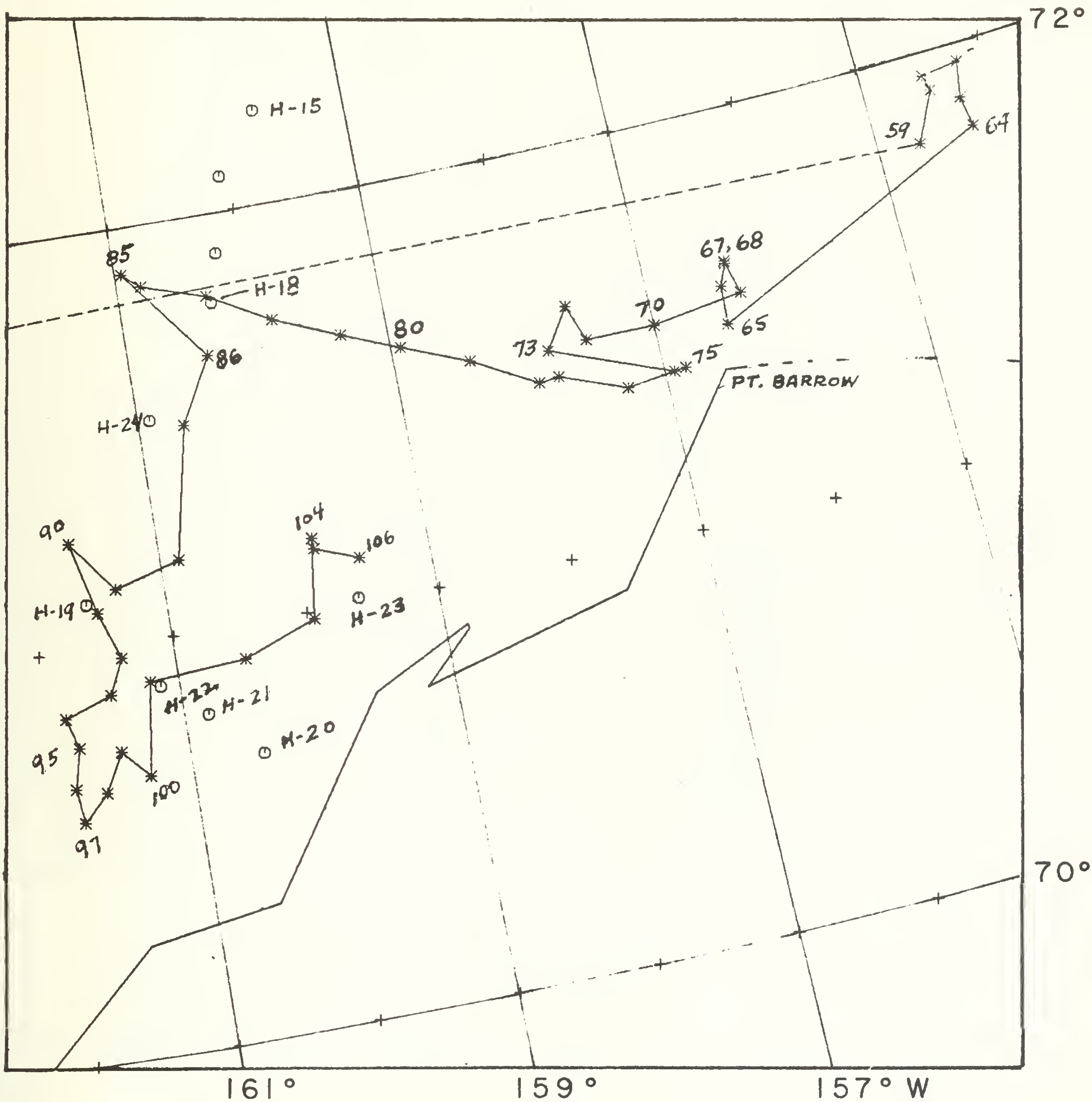


Figure 2B. Computer-drawn, expanded-scale station plot of MIZPAC 78.

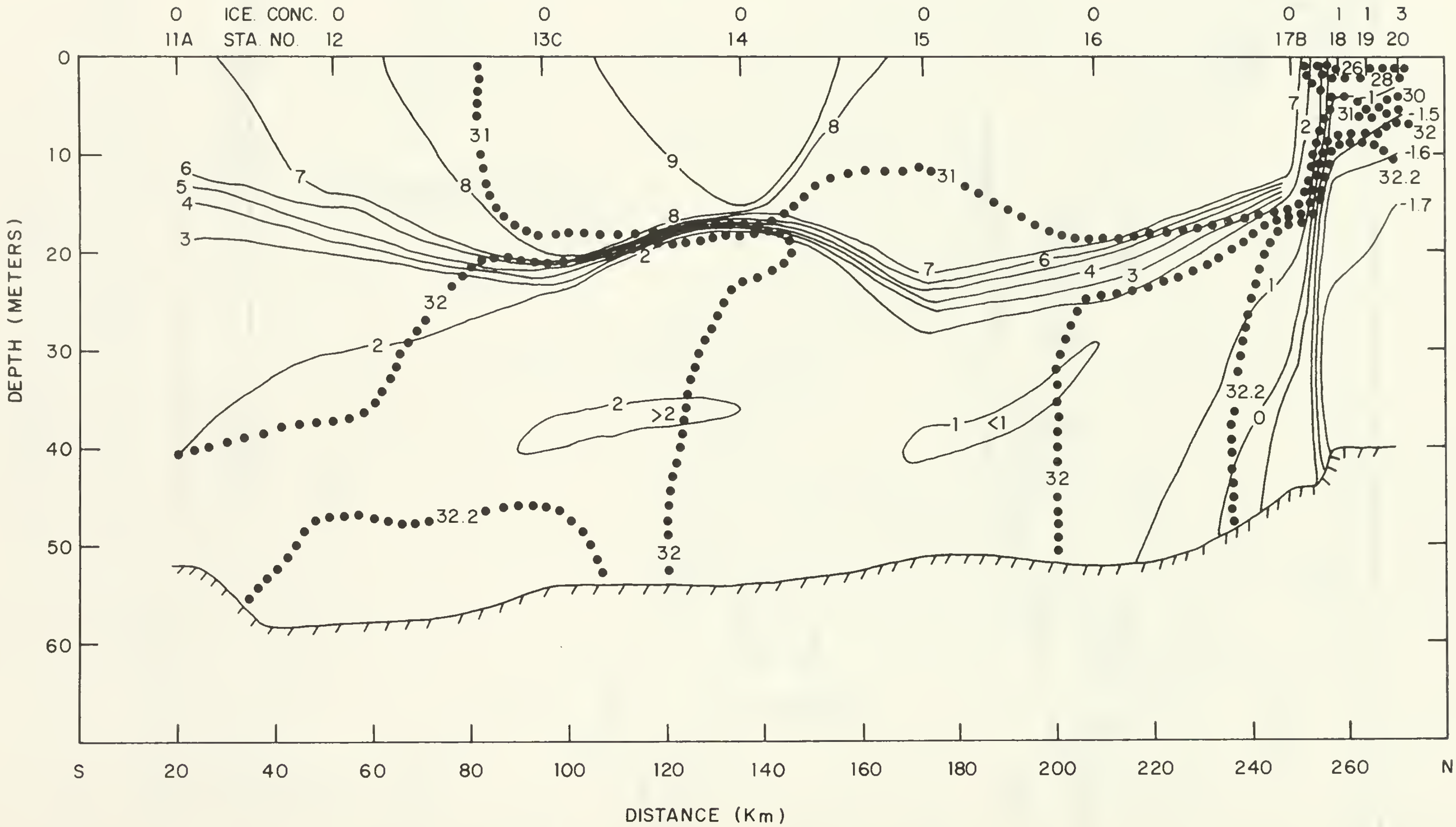


Figure 3. Temperature-salinity cross-section for Crossing No. 2. Note the coincidence of the upper and lower layer fronts between Stations 17B and 18 and the finestructure evident between Stations 13C and 16.

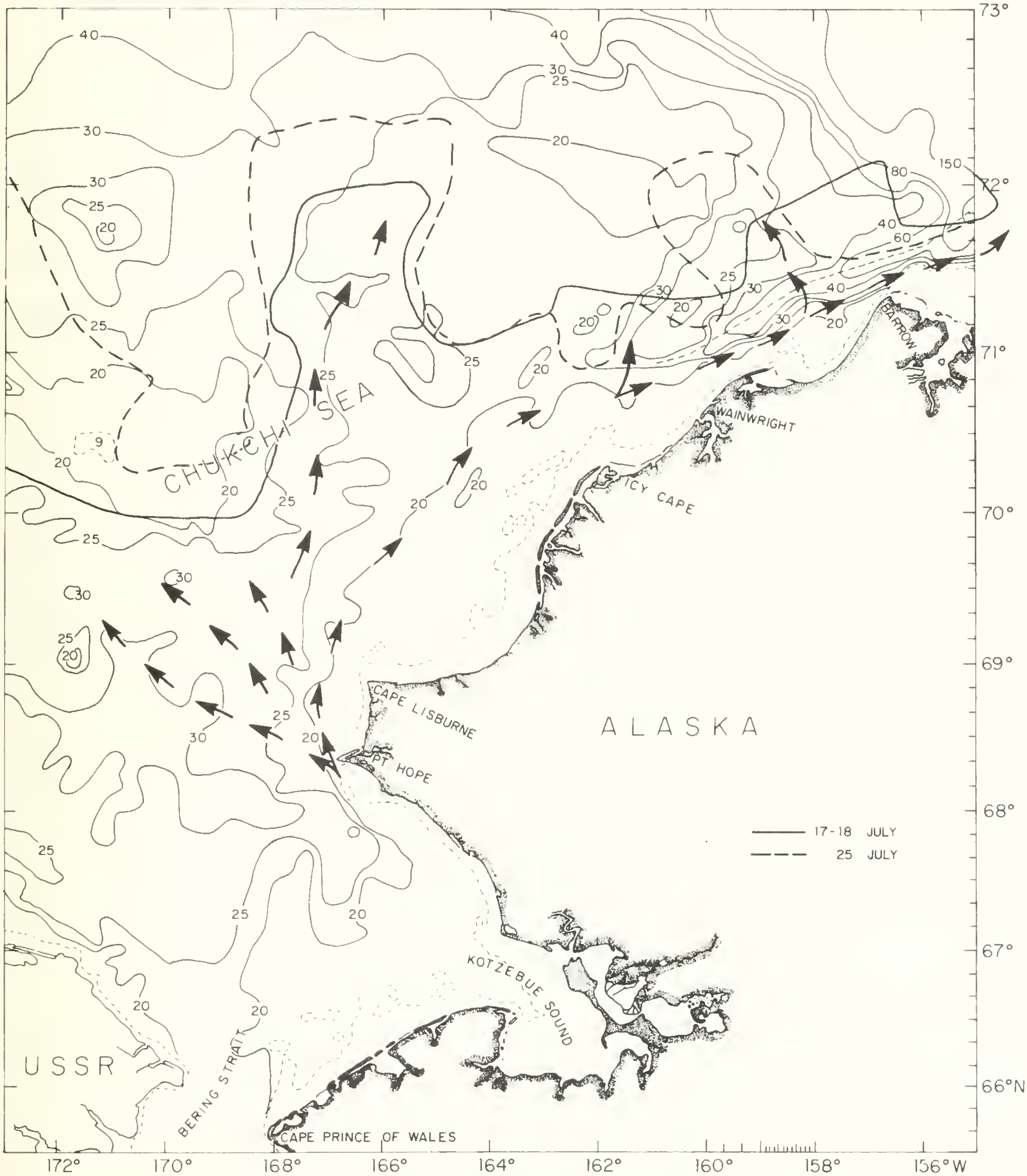


Figure 4. Schematic of upper level currents inferred from the ice melt-back pattern, temperature core analysis, and bottom bathymetry. Bottom contours are in fathoms. The solid and dashed lines indicate the position of the ice edge from aerial and satellite observations on 17-18 July and 25 July 1978, respectively.

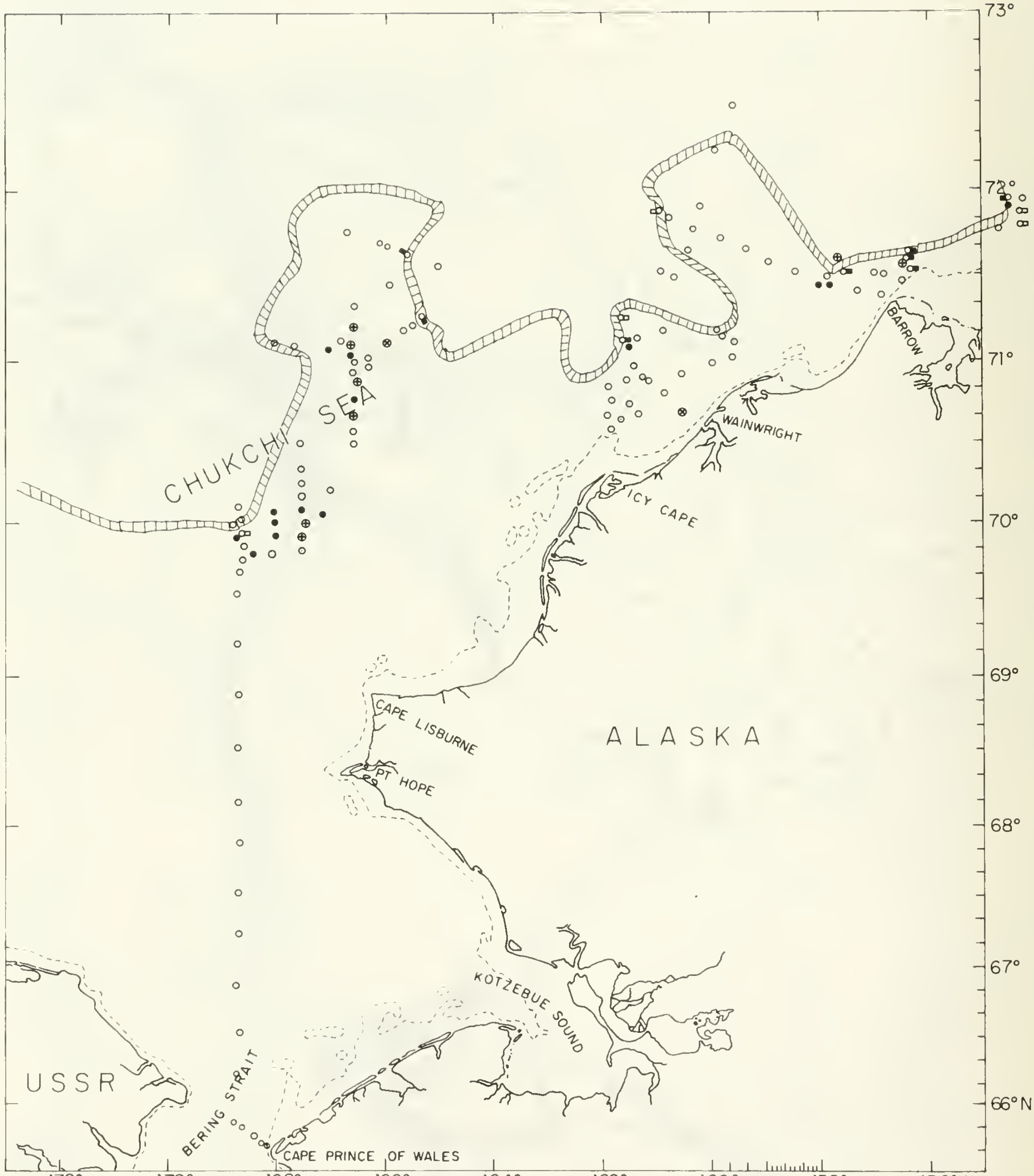


Figure 5. Distribution and intensity of fine-structure during MIZPAC 78. Symbols are described in Table 1.

TABLE I

FINESTRUCTURE CLASSIFICATION SYSTEM

SYMBOL	CATEGORY	PEAK-TO-PEAK FLUCTUATION
Open circle	Non existent	<0.2°C
Circle with dot	Weak	0.2 to 0.5°C
Circle with cross	Moderate	0.5 to 1.0°C
Solid circle	Strong	More than 1.0°C
Open tab on circle	Nose w/o structure	
Solid tab on circle	Nose with structure	

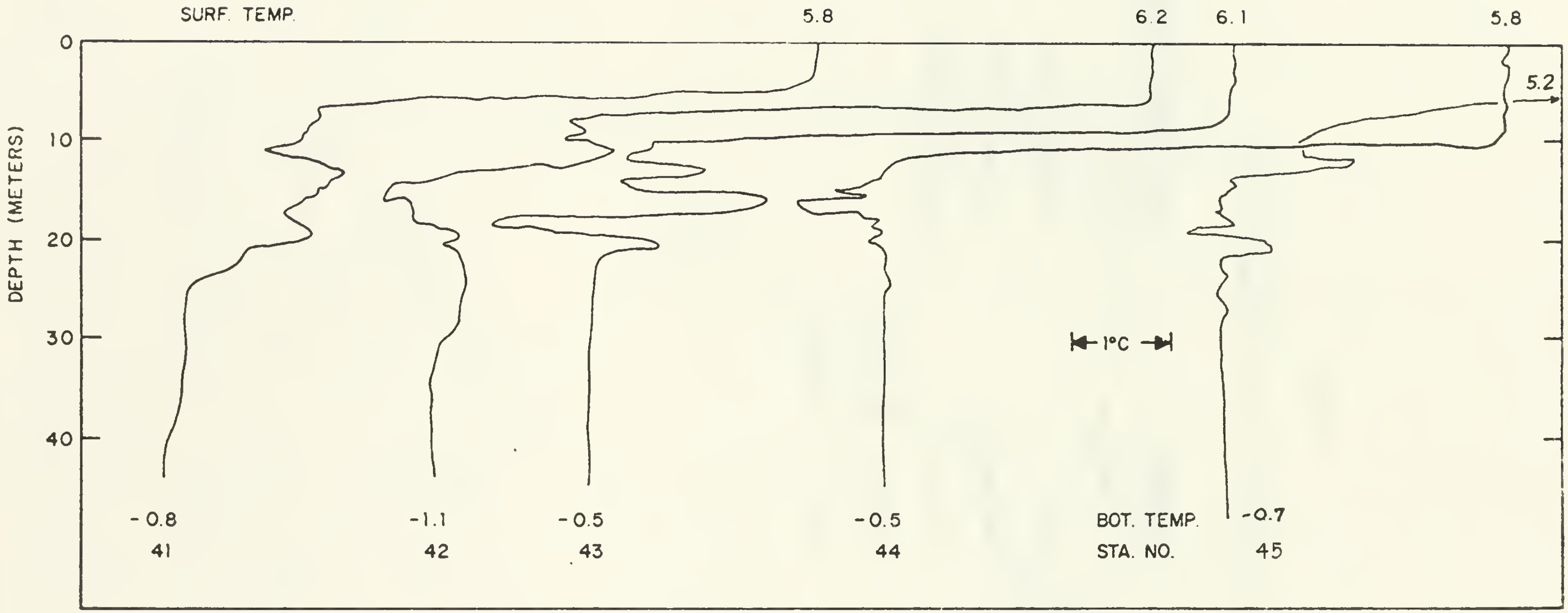


Figure 6. Nested profiles of temperature from Stations 41 through 45 illustrating the intense finestructure found within the center of the western embayment.

Thoroughly systematic exploration for fronts and finestructure in the extreme eastern Chukchi was inhibited by ice breaker limitations, i.e., the ship was reduced to short daily excursions on one screw. Nevertheless, finestructure was found northwest and east of Barrow. The deepest structure to date was found at Station 77 over the Barrow Canyon. It shows intense structure in the band between 80 and 100 m undoubtedly formed on the margins of the Alaskan Coastal Current where it has submerged in the Barrow Canyon. The notable lack of finestructure in the embayment northwest of Barrow, in contrast to the plentiful structure found under similar conditions the previous year (Graham, 1978), may have occurred because the ship did not sample the near-ice areas where finestructure activity could be expected.

Readers interested in further detail are referred to Small (1979). Further analyses based upon the entire series of MIZPAC cruises are in progress and will be published in the near future.

V. REFERENCES

Graham, G.P. (1978). Finestructure, fronts, and currents in the Pacific marginal sea-ice zone -- MIZPAC 77, Masters Thesis, Naval Postgraduate School, Monterey, Tech. Rpt. NPS 68-78-006.

Paquette, R. G. and R. H. Bourke (1973). Oceanographic measurements near the Arctic ice margins, Tech. Report NPS-58PA73121A, Department of Oceanography, Naval Postgraduate School, Monterey.

Paquette, R. G. and R. H. Bourke (1976). Oceanographic investigations of the marginal sea-ice zone of the Chukchi Sea - MIZPAC 1974, Tech. Report NPS-58PA76051, Department of Oceanography, Naval Postgraduate School, Monterey.

Paquette, R. G. and R. H. Bourke (1978). The oceanographic cruise of the USCGC BURTON ISLAND to the marginal sea-ice zone of the Chukchi Sea -- MIZPAC 77, Tech. Report NPS-68-78-001, Department of Oceanography, Naval Postgraduate School, Monterey.

Small, W. E. (1979). Finestructure, fronts, and currents in the Pacific marginal sea-ice zone -- MIZPAC 78, Masters Thesis, Naval Postgraduate School, Monterey, Tech. Rpt. NPS 68-79-002.

Zuberbuhler, W. J. and J. A. Roeder (1976). Oceanography, mesostructure and currents of the Pacific marginal sea-ice zone - MIZPAC 75, Masters Thesis, Naval Postgraduate School, Monterey, Tech. Report NPS-58PA76091.

APPENDIX A
DESPIKING AND DATA EDITING

Introduction and Modification to the NOISE Routine.

A few changes were made in the data-editing routines described by Paquette and Bourke (1978) partly to make the despiking routine more logical and partly to handle the manifold increase in the number of widely aberrant data points this year. A consequence of the latter situation is that two bad points could be adjacent. This destroyed the only reliable criterion useable for automatic noise rejection: that a noise spike differ from the preceding point by more than some minimum and that the curve return to the vicinity of the projected curve within some maximum tolerance onthe next following point. It also led to some serious feedback problems which it is unimportant to describe here. Low-level noise was more prevalent this year and Noise Spike-j not uncommonly failed to be recognized because the j + 1 -th point was outside the projection through points j-2 and j-1 by more than the usually accepted tolerance. The noise-rejection routine was modified to partly handle these problems but considerable human inspection and intervention was required to get the bad points out of the data.

Modification of the Despiking Routine.

Previously, we had combined in a lag constant, k_c, the effects due to digital sampling lag, physical displacement of the sensors from each other and the flushing lag of the conductivity cell. This was reasonably satisfactory. Although the first two effects are similar in nature, the third can be treated as similar to the first two only if all the change in electrical conductivity is due to temperature. When the salinity changes rapidly, this cannot be true and some error in the correction must result. This difficulty was removed be deriving a correction from the slope of the conductivity curve.

The new correction procedure is as follows.

1. Correct the thermometer for a time constant, k_T, (about 0.05 sec on the down trace) by the equation

$$T = T' + k_T \, dT'/dt$$

where T is the corrected temperature, T' is the observed temperature, k_T is the time constant and t is time. The correction usually is small.

2. Correct for the fact that the conductivity is sampled before the temperature and that there is a small physical vertical displacement between the two sensors. Bring the thermometer into effective coincidence with the cell by the algorithm

$$TLG_j = (1-LG)T_j + LG \cdot T_{j-1}$$

where TLG is the corrected temperature and LG is a lag constant approximating 0.30 but varying from about 0.17 to 0.5.

3. Calculate the temperature of some thermal mass in the conductivity cell which is buffered from TLG by a thermal resistance corresponding to a time constant K_3, approximately 5 sec. Call this temperature T_c.

4. Add fraction F of T_c - TLG to TLG to obtain the effective cell temperature, TEF. F varies from about 0.06 to 0.22.

5. Correct the conductivity ratio, c, as though the cell had a time constant rather than a length constant (assuming constant lowering rate) by the equation

$$c = c' + k_c \, dc'/dt$$

in analogy to temperature. Here, k_c approximates 0.20 sec.

6. Use the corrected conductivity ratio from Step 5 and the temperature from Step 4 to recompute the salinity and the derived variables, sound velocity and sigma-t. We used the Northwest Regional Calibration Center equations, although recent work indicates that a much simpler difference equation would be adequate.

While we feel that the results of this procedure are better than last year's, this is difficult to prove because the constants are not fixed. They vary, probably mostly due to differences in lowering rates. Good correction still depends upon skill in adjusting the constants and it is not much easier to do so this year than last year.

Some Examples

Some appreciation of the data editing task may be had by examining the plotted data before editing for one group of stations in comparison with the final edited results. Figure 7 shows Stations 11B, 14, 15 and 17B before editing and Figure 8 the same stations afterward. The excursions to wild points have been stopped at the graph frame. The number of wild points is fairly typical of most of the stations. However, one feature not seen in most of the stations is the distortions due to the ship's roll which may be seen in Stations 14 and 15. Loops due to rolling of the ship are visible in the temperature and salinity traces in the unedited data. They are more notable in the salinity. This is a situation in which despiking is not very successful because the spikes are due to changes in the lowering rate and some complex behavior of the thermometer, cell and pressure sensor. The cell quickly shows the effects of self-heating when stalled and the time constant of the cell increases at slow flushing rates. Pressure sensor hysteresis would be an additional complication. On the other hand, the dominant spike due to the sharp temperature transient, which is seen most easily in Station 14, is efficiently removed.

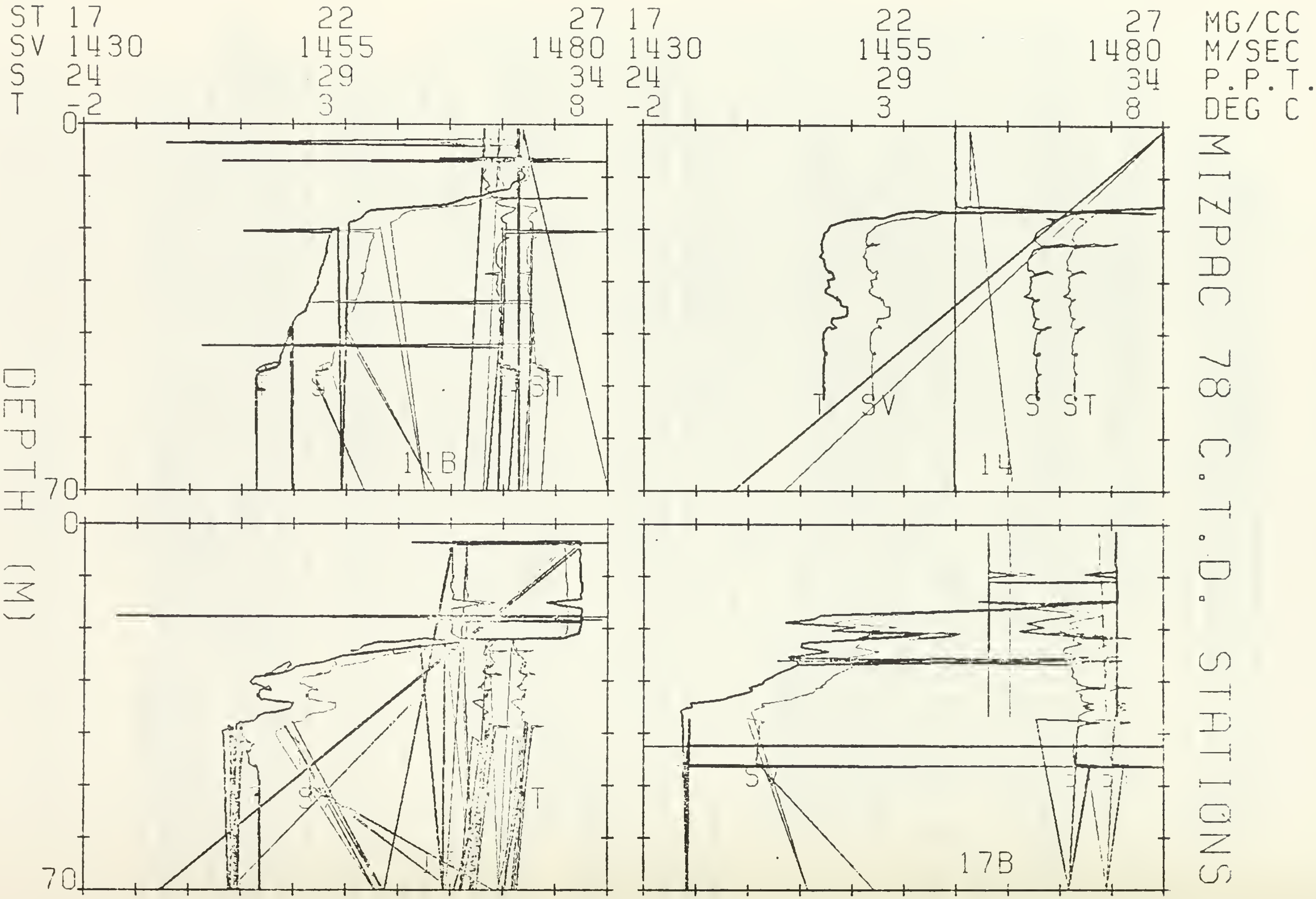


Figure 7. Property profiles from four MIZPAC 78 stations prior to editing to remove noise and temperature induced salinity spikes.

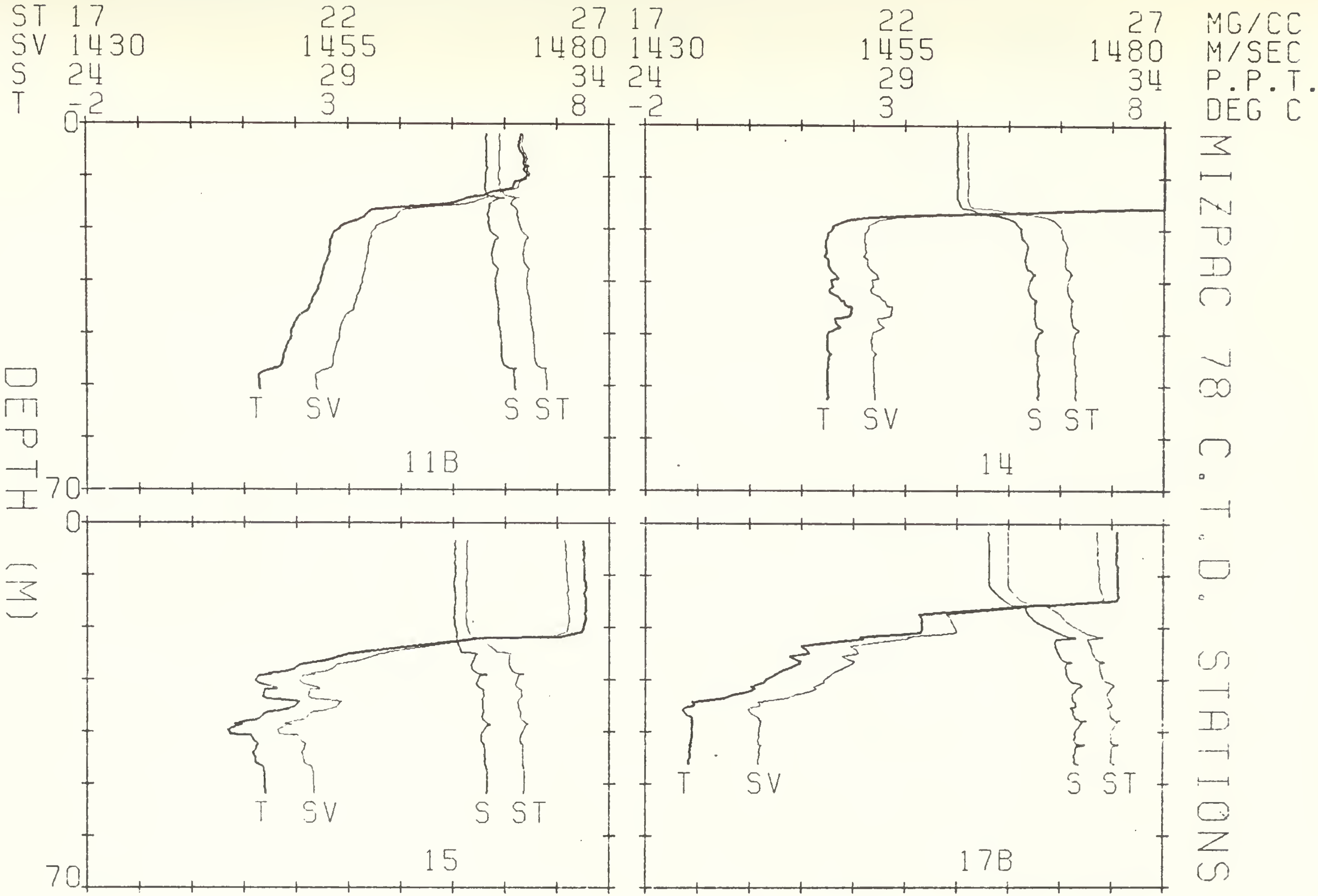


Figure 8. Property profiles from the same stations in Figure 7 after editing. The improvement is considerable but spiking, probably due to higher order effects, still remains.

The small amount of smoothing we use, a running mean over 5 points, does not remove the noise due to rolling of the ship primarily because depth changes more slowly than normal after the ratchet subroutine is applied. The noise spikes, although narrow in depth, represent two or more times as many points as the usual three per meter. This reduces the effectiveness of smoothing over a fixed number of points. More drastic smoothing is undesirable not only because of the tendency for unrealistic broadening of real transients and sharp breaks but also because the noise spikes due to rolling are one-sided and drastic smoothing raises the apparent salinity. It should be noted that temperature is not smoothed except insofar as it is a result of the ratchet applied to the depth.

It should be emphasized that the spikiness evident in the edited data of Figure 8 is not typical of most of the stations. An examination of the complete data in Appendix D will show that most of the salinity curves are relatively well behaved.

APPENDIX B

EXPLANATION OF HEADING CODES

The heading of the printed output uses the coding and format from NODC Publication M-2, August 1964, with a few exceptions. Heading entries which are not self-explanatory are as follows: MSQ is the Marsden Square, and DPTH is the water depth in meters. Wave source direction is in tens of degrees, but the direction 99 indicates no observation. The significant wave height is coded by Table 10 (Code $\div$ 2 $\approx$ height in meters) and the wave period is coded by Table 11 (COde $\div$ 2 $\approx$ period in sec); in each case X indicates no observation. Wind speed, V, is coded as Beaufort force, Table 17. The barometer is in millibars, less 1000 if more than 3 digits; wet and dry bulb temperature in degrees C. The present weather is from Table 21 with cloud type and amount from Tables 25 and 26, respectively. The combination 4 X 9 indicates that clouds cannot be observed usually because of fog conditions. The visibility is from Table 27 which is roughly in powers of two with Code 4 = 1-2 km. The ice concentration, IC, is in oktas; amounts less than 1 okta are preceded by a minus sign and indicate concentrations in powers of ten, e.g., $10^{-4} = -4$.

The entry, COD, is a code to identify the accuracy of each station position based upon the navigation system used. Code 1 indicates a position determined by visual sightings, radar or by navigation satellite; Code 2 a position determined by Omega or Loran; and Code 3 a position determined by dead reckoning.

APPENDIX C

HEADING DATA FOR MIZPAC 78 STATIONS

Heading data are listed on the following pages for MIZPAC 78. The coding conventions are those described in Appendix B. The CTD lowerings made from the ship are listed first, Station 1 through 106. Stations with an A, B or C are replicated stations, normally made to test the performance of one of the CTD's. The helicopter stations, 1H through 24H, are listed separately; note that much of the climatological data are missing from the helicopter lowerings.

MIZPAC 78 CTD STATIONS

NAT	SHIP	LAT	LONG	MSQ	MO	DY	YR	HR	STA	DPTH	COD	IC	WVD	HT	PER	WND	V	BAR	DRY	WET	WTHR	CL	AMT	VIS
31	GL	65-41.9	168-14.6	233	07	15	78	18.2	001	43	1	0	27	2		27	4	131	8.3	7.8	1	7	3	7
31	GL	65-42.7	168-24.0	233	07	15	78	19.8	002	52	1	0	28	2		28	3	131	9.5	8.8	1	3	2	7
31	GL	65-46.0	168-32.0	233	07	15	78	21.2	003	56	1	0	28	1		31	3	143	8.9	7.8	1	4	3	8
31	GL	65-49.3	168-42.5	233	07	15	78	22.7	004	46	1	0	30	2		30	4	134	7.2	6.6	0	0	3	8
31	GL	65-53.0	168-51.0	233	07	16	78	00.6	005	49	1	0	31	2		31	3	125	7.0	6.2	1	0	4	7
31	GL	66-12.6	168-46.7	233	07	16	78	03.2	006	52	1	0	33	1		33	3	117	7.2	7.6	1	0	4	8
31	GL	66-31.6	168-45.1	233	07	16	78	06.2	007A	48	2	0	34	1		34	5	114	8.8	7.7	1	0	4	8
31	GL	66-31.6	168-45.1	233	07	16	78	06.9	007B	48	2	0	34	1		34	5	114	8.8	7.7	1	0	4	8
31	GL	66-52.6	168-49.9	233	07	16	78	09.3	008	40	2	0	33	1		33	4	112	6.7	5.6	1	0	2	7
31	GL	67-14.7	168-45.0	233	07	16	78	12.2	009	48	1	0	33	1		33	4	099	5.6	5.0	1	0	2	7
31	GL	67-32.5	168-45.1	233	07	16	78	14.7	010A	48	1	0	34	2		34	4	094	6.6	5.6	1	3	2	7
31	GL	67-32.5	168-45.1	233	07	16	78	15.4	010B	48	1	0	34	2		34	4	094	6.6	5.6	1	3	2	7
31	GL	67-52.5	168-40.0	233	07	16	78	17.9	011A	48	2	0	04	2		04	4	095	9.0	7.8	1	0	1	7
31	GL	67-52.5	168-40.0	233	07	16	78	18.6	011B	48	2	0	04	2		04	4	095	9.0	7.8	1	0	1	7
31	GL	68-09.2	168-50.0	233	07	16	78	21.8	012	48	3	0	05	2		05	4	112	11.2	9.2	1	0	1	8
31	GL	68-32.5	168-45.5	233	07	17	78	02.5	013A	51	2	0	03	3		03	5	109	8.6	7.2	1	0	2	8
31	GL	68-32.5	168-45.5	233	07	17	78	02.8	013B	51	2	0	03	3		03	5	109	8.6	7.2	1	0	2	8
31	GL	68-32.5	168-45.5	233	07	17	78	03.2	013C	51	2	0	03	3		03	5	109	8.6	7.2	1	0	2	8
31	GL	68-54.0	168-45.0	233	07	17	78	06.3	014	49	2	0	04	3		04	5	103	7.3	6.9	1	0	3	3
31	GL	69-14.0	168-45.5	233	07	17	78	09.8	015	55	2	0	04	3		04	6	101	6.1	5.6	4	X	3	6

MIZPAC 78 CTD STATIONS

NAT	SHIP	LAT	LONG	MSQ	MO	DY	YR	HR	STA	DPTH	COD	IC	WVD	HT	PER	WND	V	BAR	DRY	WET	WTHR	CL	AMT	VIS
31	GL	69-33.0	168-43.5	233	07	17	78	12.8	016	51	2	0	04	5		04	6	093	6.2	5.8	4	X	9	6
31	GL	69-55.0	168-46.8	233	07	17	78	16.2	017A	46	2	0	01	0		01	4	083	3.9	3.9	4	X	9	2
31	GL	69-55.0	168-46.8	233	07	17	78	16.8	017B	46	2	0	01	0		01	4	083	3.9	3.9	4	X	9	2
31	GL	70-00.0	168-41.0	269	07	17	78	18.5	018	44	2	1	14	0		14	4	088	6.0	5.4	1	0	2	7
31	GL	70-03.0	168-40.0	269	07	17	78	20.3	019	31	2	1	00	0		18	4	089	4.8	4.7	4	X	9	3
31	GL	70-06.0	168-41.0	269	07	17	78	21.6	020	42	2	3	00	0		30	3	096	2.5	2.3	4	X	9	1
31	GL	70-01.5	168-40.0	269	07	17	78	23.3	021	37	2	4	00	0		21	3	114	1.8	1.7	4	X	9	2
31	GL	69-56.3	168-41.0	233	07	18	78	01.0	022	42	2	3	00	0		23	3	127	2.8	2.3	4	X	9	5
31	GL	69-51.0	168-38.0	233	07	18	78	02.9	023	44	2	0	25	1		25	3	131	4.8	4.4	4	X	9	5
31	GL	69-46.5	168-42.0	233	07	18	78	04.2	024	51	2	0	23	1		17	3	132	5.3	5.1	4	X	9	3
31	GL	69-41.0	168-42.5	233	07	18	78	05.2	025	50	2	0	14	1		15	2	134	5.5	5.4	4	X	9	3
31	GL	69-48.8	168-27.5	233	07	18	78	07.0	026	52	2	0	14	1		14	3	133	6.8	6.8	4	X	9	3
31	GL	69-48.0	168-05.0	233	07	18	78	09.2	027	49	2	0	13	1		13	3	140	6.4	6.4	4	X	9	1
31	GL	69-55.4	168-01.6	233	07	18	78	11.1	028	52	2	0	13	1		13	3	139	6.7	6.2	1	8	3	4
31	GL	70-01.0	168-03.0	269	07	18	78	12.2	029	45	2	0	07	2		12	3	139	7.8	7.5	1	6	6	7
31	GL	70-05.0	168-03.0	269	07	18	78	13.7	030	46	3	0	13	1		13	2	137	9.4	8.1	1	6	6	7
31	GL	69-55.5	167-33.0	233	07	18	78	15.9	031	45	2	0	00	0		17	3	141	8.2	7.7	2	3	1	7
31	GL	69-50.2	167-33.0	233	07	18	78	16.9	032	48	1	0	19	1		18	4	150	6.7	6.6	4	X	9	2
31	GL	70-01.0	167-30.0	269	07	18	78	18.5	033	49	2	0	19	1		20	5	150	7.2	6.9	1	7	8	7
31	GL	70-05.5	167-34.0	269	07	18	78	20.3	034	49	2	0	20	2		20	4	153	7.7	7.0	2	7	8	7

MIZPAC 78 CTD STATIONS

NAT	SHIP	LAT	LONG	MSQ	MO	DY	YR	HR	STA	DPTH	COD	IC	WVD	HT	PER	WND	V	BAR	DRY	WET	WTHR	CL	AMT	VIS
31	GL	70-10.5	167-33.0	269	07	18	78	22.4	035	49	2	0	19	1		19	4	165	7.3	6.9	2	7	8	4
31	GL	70-14.9	167-33.5	269	07	19	78	00.2	036	47	2	0	20	2		19	4	164	7.3	6.9	4	X	9	2
31	GL	70-30.2	166-36.0	269	07	19	78	03.4	037	47	1	0	20	2		20	3	162	6.7	6.7	4	X	9	1
31	GL	70-35.0	166-35.0	269	07	19	78	04.8	038	41	2	0	19	2		17	4	164	6.6	6.6	4	X	9	1
31	GL	70-41.2	166-35.8	269	07	19	78	05.7	039	44	1	0	24	2		24	3	163	6.8	6.6	4	X	9	1
31	GL	70-46.5	166-35.0	269	07	19	78	06.9	040	42	2	0	19	2		17	3	164	6.3	6.3	4	X	9	1
31	GL	70-53.5	166-32.0	269	07	19	78	07.8	041	44	2	0	18	2		18	3	165	6.1	6.1	4	X	9	2
31	GL	70-56.3	166-35.5	269	07	19	78	08.5	042	46	2	0	18	2		18	4	165	5.8	5.6	4	X	9	2
31	GL	71-02.5	166-38.0	269	07	19	78	09.7	043	46	2	0	20	1		20	4	165	5.7	5.7	4	X	9	2
31	GL	71-06.5	166-40.0	269	07	19	78	10.3	044	46	2	0	18	2		19	4	164	5.5	5.5	4	X	9	1
31	GL	71-12.5	166-35.0	269	07	19	78	11.8	045	47	2	0	19	2		17	3	162	4.5	4.5	4	X	9	1
31	GL	71-20.0	166-35.0	269	07	19	78	13.7	046A	46	2	0	15	2		15	3	152	3.9	3.9	1	0	1	6
31	GL	71-20.0	166-35.0	269	07	19	78	13.7	046B	46	2	0	15	2		15	3	152	3.9	3.9	1	0	1	6
31	GL	70-53.5	166-20.0	269	07	19	78	17.4	047	45	2	0	21	1		00	0	150	7.2	6.9	1	3	3	7
31	GL	71-01.0	166-20.0	269	07	19	78	20.1	048	46	3	0	16	1		07	3	144	7.5	6.8	1	3	1	7
31	GL	71-09.0	168-16.0	269	07	20	78	02.1	049	44	2	2	00	0		00	0	139	6.2	5.6	1	0	2	8
31	GL	71-09.0	168-10.0	269	07	20	78	07.5	050	51	2	0	00	0		10	2	131	5.8	5.6	1	3	3	6
31	GL	71-07.0	166-50.0	269	07	20	78	11.2	051	47	2	0	00	0		10	3	125	6.7	5.9	1	3	4	8
31	GL	71-07.0	165-55.0	269	07	20	78	14.2	052	45	2	0	05	1		05	3	119	4.2	3.6	1	3	7	6
31	GL	71-13.0	165-28.0	269	07	20	78	17.4	053	42	2	0	00	0		02	4	125	2.2	1.4	1	3	7	6

MIZPAC 78 CTD STATIONS

NAT	SHIP	LAT	LONG	MSQ	MO	DY	YR	HR	STA	DPTH	COD	IC	WVD	HT	PER	WND	V	BAR	DRY	WET	WTHR	CL	AMT	VIS
31	GL	71-11.2	165-40.0	269	07	20	78	19.0	054	38	2	0	05	1		05	4	124	3.9	3.6	1	3	7	7
31	GL	71-15.0	165-22.0	269	07	20	78	20.2	055	37	2	-3	00	0		07	4	126	1.8	1.7	1	3	7	6
31	GL	71-16.5	165-20.0	269	07	20	78	23.7	056	42	2	3	00	0		05	3	131	3.3	2.5	1	3	7	6
31	GL	71-27.8	165-55.0	269	07	21	78	04.0	057	42	2	0	00	0		08	2	131	3.3	2.5	1	3	6	7
31	GL	71-41.0	166-00.0	269	07	21	78	06.4	058A	42	2	0	00	0		05	2	137	4.4	5.4	1	3	6	7
31	GL	71-41.0	166-00.0	269	07	21	78	06.4	058B	42	2	0	00	0		05	2	137	4.4	5.4	1	3	6	7
31	GL	71-46.9	154-40.0	268	07	23	78	06.2	059A	154	2	0	03	1		03	3	144	2.8	1.8	2	6	7	7
31	GL	71-46.9	154-40.0	268	07	23	78	06.4	059B	154	2	0	03	1		03	3	144	2.8	1.8	2	6	7	7
31	GL	71-54.2	154-28.5	268	07	23	78	07.4	060A	202	2	-2	00	0		02	2	146	2.2	1.2	2	6	7	6
31	GL	71-54.2	154-28.5	268	07	23	78	07.6	060B	202	2	-2	00	0		02	2	146	2.2	1.2	2	7	6	7
31	GL	71-56.5	154-30.5	268	07	23	78	08.2	061	201	2	0	00	0		04	3	147	1.7	1.4	4	X	9	3
31	GL	71-57.2	154-13.0	268	07	23	78	09.4	062	205	2	0	00	0		15	2	150	1.1	1.1	4	X	9	1
31	GL	71-52.0	154-16.0	268	07	23	78	10.3	063A	200	2	0	00	0		03	2	145	1.2	0.7	4	X	9	2
31	GL	71-52.0	154-16.0	268	07	23	78	10.4	063B	200	2	0	00	0		03	2	145	1.2	0.7	4	X	9	2
31	GL	71-47.5	154-14.0	268	07	23	78	11.8	064	119	2	0	00	0		29	4	146	3.1	1.4	4	X	9	1
31	GL	71-28.4	156-27.2	268	07	24	78	02.6	065A	050	1	0	00	0		34	4	146	4.7	4.4	0	0	3	8
31	GL	71-28.4	156-27.2	268	07	24	78	02.6	065B	050	1	0	00	0		34	4	146	4.7	4.4	0	0	3	8
31	GL	71-34.0	156-26.0	268	07	24	78	03.8	066	150	1	0	00	0		03	6	143	5.2	3.3	1	0	6	7
31	GL	71-37.2	156-22.0	268	07	24	78	05.2	067	160	2	2	00	0		28	3	143	4.7	4.2	1	0	5	7
31	GL	71-37.5	156-22.0	268	07	24	78	06.2	068	101	2	7	00	0		26	2	144	1.7	1.4	1	0	6	7

MIZPAC 78 CTD STATIONS

NAT	SHIP	LAT	LONG	MSQ	MO	DY	YR	HR	STA	DPTH	COD	IC	WVD	HT	PER	WND	V	BAR	DRY	WET	WTHR	CL	AMT	VIS
31	GL	71-32.5	156-18.0	268	07	24	78	07.9	069	157	2	-3	00	0		00	0	148	5.8	4.7	1	3	6	7
31	GL	71-30.8	157-00.0	268	07	24	78	09.5	070	152	2	0	00	0		31	4	141	5.8	4.3	1	3	7	7
31	GL	71-31.0	157-32.0	268	07	24	78	11.7	071	82	2	0	00	0		35	4	140	8.8	8.2	1	3	6	7
31	GL	71-36.4	157-38.0	268	07	24	78	13.0	072	62	2	1	00	0		31	5	141	3.4	3.2	1	6	7	7
31	GL	71-30.5	157-50.0	268	07	24	78	15.8	073	122	2	-4	00	0		32	2	141	3.4	2.2	4	6	7	7
31	GL	71-23.6	156-56.0	268	07	24	78	17.2	074	110	2	0	00	0		33	2	146	4.2	3.6	4	3	5	6
31	GL	71-23.7	156-50.5	268	07	25	78	07.0	075	36	1	0	00	0		35	4	154	4.1	2.9	4	7	8	6
31	GL	71-22.8	157-18.1	268	07	25	78	08.2	076	119	1	0	00	0		33	2	151	1.3	1.1	4	X	9	1
31	GL	71-26.5	157-48.0	268	07	25	78	10.5	077	110	1	-4	00	0		27	2	161	0.7	0.6	4	X	9	2
31	GL	71-26.3	157-57.0	268	07	25	78	11.8	078	82	2	-4	00	0		25	3	160	1.1	0.5	4	X	9	1
31	GL	71-31.5	158-26.0	268	07	25	78	13.5	079	60	2	0	00	0		26	4	153	1.1	0.6	4	X	9	1
31	GL	71-35.5	158-56.0	268	07	25	78	14.8	080	48	2	0	00	0		22	3	149	1.9	1.7	2	7	8	2
31	GL	71-39.0	159-22.0	268	07	25	78	16.7	081	53	2	0	21	2		20	3	148	3.6	2.8	1	7	7	7
31	GL	71-43.0	159-51.8	268	07	25	78	18.3	082	49	2	0	20	2		20	3	143	1.8	1.4	4	3	7	7
31	GL	71-48.0	160-20.0	269	07	25	78	19.8	083	40	2	0	19	2		19	4	132	2.7	2.2	4	6	7	6
31	GL	71-51.0	160-45.0	269	07	25	78	20.9	084	46	2	0	18	2		19	4	139	2.7	2.2	1	6	7	7
31	GL	71-53.1	160-57.0	269	07	25	78	22.5	085	44	2	1	00	0		19	3	133	1.9	1.9	4	X	9	1
31	GL	71-39.5	160-24.0	269	07	26	78	02.0	086	46	2	0	22	1		19	3	125	5.6	4.3	0	0	1	8
31	GL	71-30.0	160-40.0	269	07	26	78	06.0	087	47	2	6	00	0		19	5	104	3.7	3.2	0	0	1	7
31	GL	71-10.8	160-52.0	269	07	26	78	12.7	088	53	2	0	19	1		21	5	094	6.1	5.3	1	3	5	8

MIZPAC 78 CTD STATIONS

NAT	SHIP	LAT	LONG	MSQ	MO	DY	YR	HR	STA	DPTH	COD	IC	WVD	HT	PER	WND	V	BAR	DRY	WET	WTHR	CL	AMT	VIS
31	GL	71-08.0	161-22.0	269	07	26	78	14.6	089	47	2	1	20	2		19	5	085	6.7	5.7	1	3	6	7
31	GL	71-15.5	161-40.0	269	07	26	78	16.6	090	42	2	-8	21	2		22	5	073	4.6	3.8	1	2	7	7
31	GL	71-05.0	161-31.5	269	07	26	78	18.4	091A	42	2	-8	21	1		21	5	076	6.7	5.3	1	2	7	7
31	GL	71-05.0	161-31.5	269	07	26	78	18.7	091B	42	2	-8	21	1		21	5	076	6.7	5.3	1	2	7	7
31	GL	71-05.0	161-31.5	269	07	26	78	18.9	091C	42	2	-8	21	1		21	5	076	6.7	5.3	1	2	7	7
31	GL	70-58.0	161-24.0	269	07	26	78	22.6	092	48	2	-3	49	2		23	5	084	6.6	5.6	2	7	8	6
31	GL	70-52.9	161-31.0	269	07	27	78	01.1	093	40	2	-3	22	3		22	4	086	7.4	6.7	2	7	8	6
31	GL	70-50.4	161-52.0	269	07	27	78	03.0	094	45	2	0	23	3		23	5	082	6.2	5.8	2	7	8	1
31	GL	70-46.0	161-48.0	269	07	27	78	04.3	095	43	2	0	23	3		24	5	089	7.0	6.7	4	X	9	1
31	GL	70-40.2	161-52.0	269	07	27	78	05.3	096	41	2	0	23	3		25	5	090	7.0	6.8	4	X	9	1
31	GL	70-35.1	161-50.0	269	07	27	78	06.2	097	37	2	0	23	2		25	4	099	7.1	6.8	4	X	9	1
31	GL	70-39.0	161-39.0	269	07	27	78	07.0	098	44	2	0	25	2		36	4	111	4.9	4.2	2	7	8	7
31	GL	70-44.5	161-30.0	269	07	27	78	08.5	099	42	2	0	24	3		36	4	120	3.1	2.5	2	7	8	7
31	GL	70-40.5	161-19.0	269	07	27	78	09.1	100	48	2	0	26	2		03	3	125	2.8	1.9	1	3	6	6
31	GL	70-54.0	161-13.0	269	07	27	78	09.9	101	49	2	-4	00	0		35	3	133	-0.3	-0.3	4	0	2	2
31	GL	70-55.0	160-30.0	269	07	27	78	11.9	102	59	2	-4	26	1		02	3	139	0.8	0.6	2	7	8	6
31	GL	70-59.0	159-57.0	268	07	27	78	13.5	103	62	1	0	22	1		01	3	142	0.7	-0.1	2	6	7	6
31	GL	71-10.5	159-52.0	268	07	27	78	15.0	104	73	1	1	00	0		03	2	149	0.8	0.1	1	4	7	6
31	GL	71-09.0	159-52.0	268	07	27	78	16.6	105	72	2	1	00	0		00	2	153	0.3	0.0	6	7	7	7
31	GL	71-06.5	159-32.5	268	07	27	78	18.6	106	68	2	1	00	0		01	2	153	1.1	0.2	4	7	8	1

MIZPAC 78 CTD STATIONS

NAT	SHIP	LAT	LONG	MSQ	MO	DY	YR	HR	STA	DPTH	COD	IC	WVD	HT	PER	WND	V	BAR	DRY	WET	WTHR	CL	AMT	VIS
31	GL	70-30.0	167-34.0	269	07	18	78	22.3	001H	33	2													
31	GL	70-20.6	167-33.0	269	07	18	78	22.4	002H	49	2													
31	GL	70-12.0	167-00.5	269	07	18	78	22.5	003H	48	2													
31	GL	70-04.2	167-10.6	269	07	18	78	22.7	004H	45	2													
31	GL	71-07.0	168-05.0	269	07	19	78	17.1	005H	51	3	6												
31	GL	71-06.0	167-42.0	269	07	19	78	17.2	006H	49	3	3												
31	GL	71-05.0	167-02.0	269	07	19	78	17.4	007H	46	3													
31	GL	71-00.7	166-34.2	269	07	19	78	19.5	008H	44	3													
31	GL	71-00.7	166-34.2	269	07	19	78	18.5	009H	40	3													
31	GL	71-00.7	166-34.2	269	07	19	78	18.5	010H	40	3													
31	GL	71-34.9	165-00.5	269	07	20	78	22.5	011H	40	2													
31	GL	71-39.1	165-34.9	269	07	20	78	22.7	012H	41	2													
31	GL	71-42.0	166-06.0	269	07	20	78	23.1	013H	45	2													
31	GL	71-46.0	166-42.0	269	07	20	78	23.3	014H	47	2													
31	GL	72-13.7	159-43.0	268	07	26	78	04.1	015H	58	2													
31	GL	72-05.0	160-04.0	269	07	26	78	04.3	016H	71	2													
31	GL	71-54.0	160-12.0	269	07	26	78	04.5	017H	79	2													
31	GL	71-47.0	160-18.0	269	07	26	78	04.8	018H	75	2													
31	GL	71-06.4	161-36.0	269	07	26	78	16.2	019H	46	2													
31	GL	70-41.1	160-29.0	269	07	26	78	16.4	020H	29	2													

MIZPAC 78 CTD STATICNS

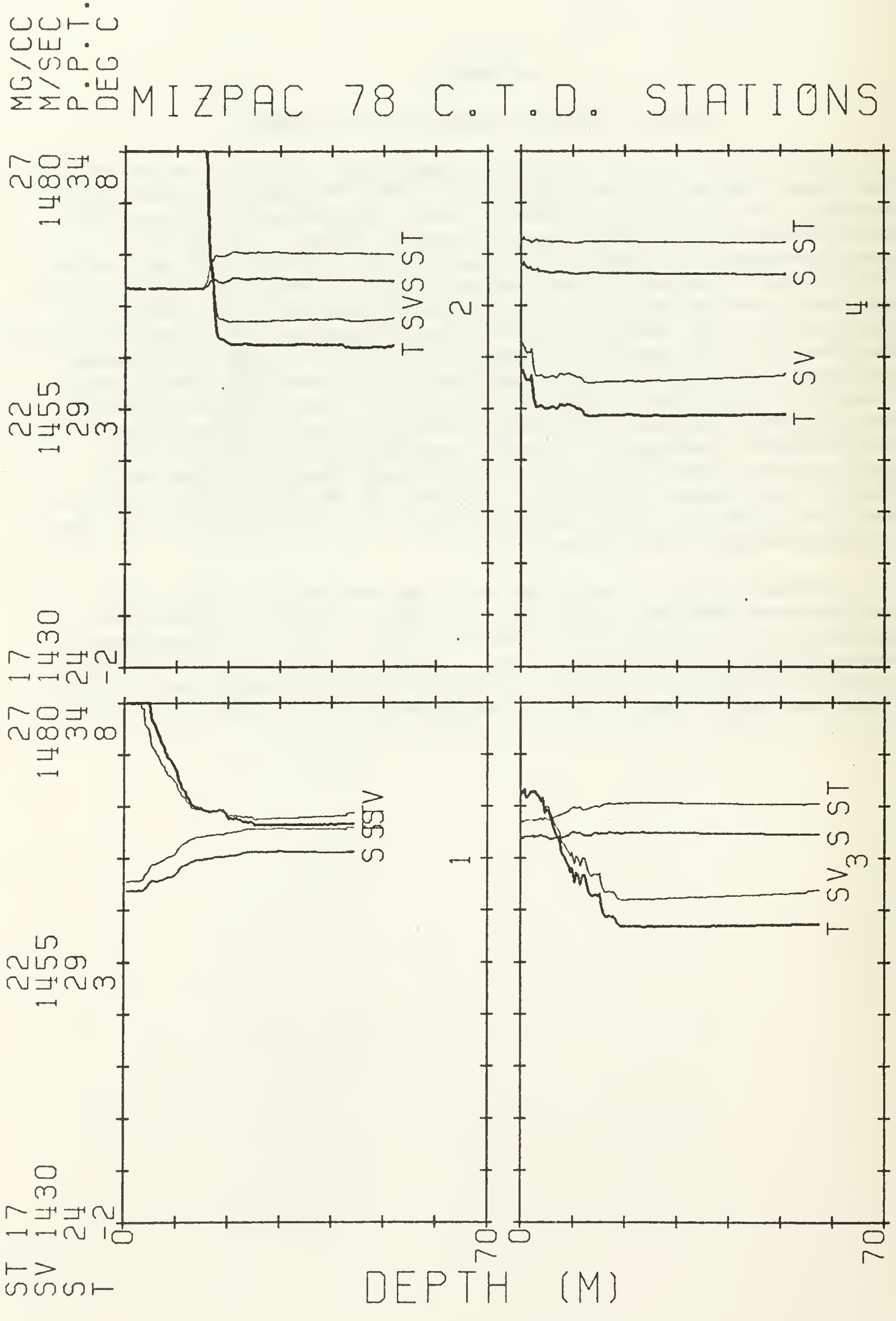
NAT	SHIP	LAT	LONG	MSQ	MO	DY	YR	HR	STA	DPTH	COD	IC	WVD	HT	PER	WND	V	BAR	DRY	WET	WTHR	CL	AMT	VIS
31	GL	70-48.0	160-50.0	269	07	26	78	16.5	021H	47	2													
31	GL	70-53.1	161-09.0	269	07	26	78	16.8	022H	47	2													
31	GL	71-00.8	159-36.0	268	07	27	78	16.1	023H	79	1													
31	GL	71-31.5	160-55.0	269	07	27	78	16.5	024H	47	1													

APPENDIX D

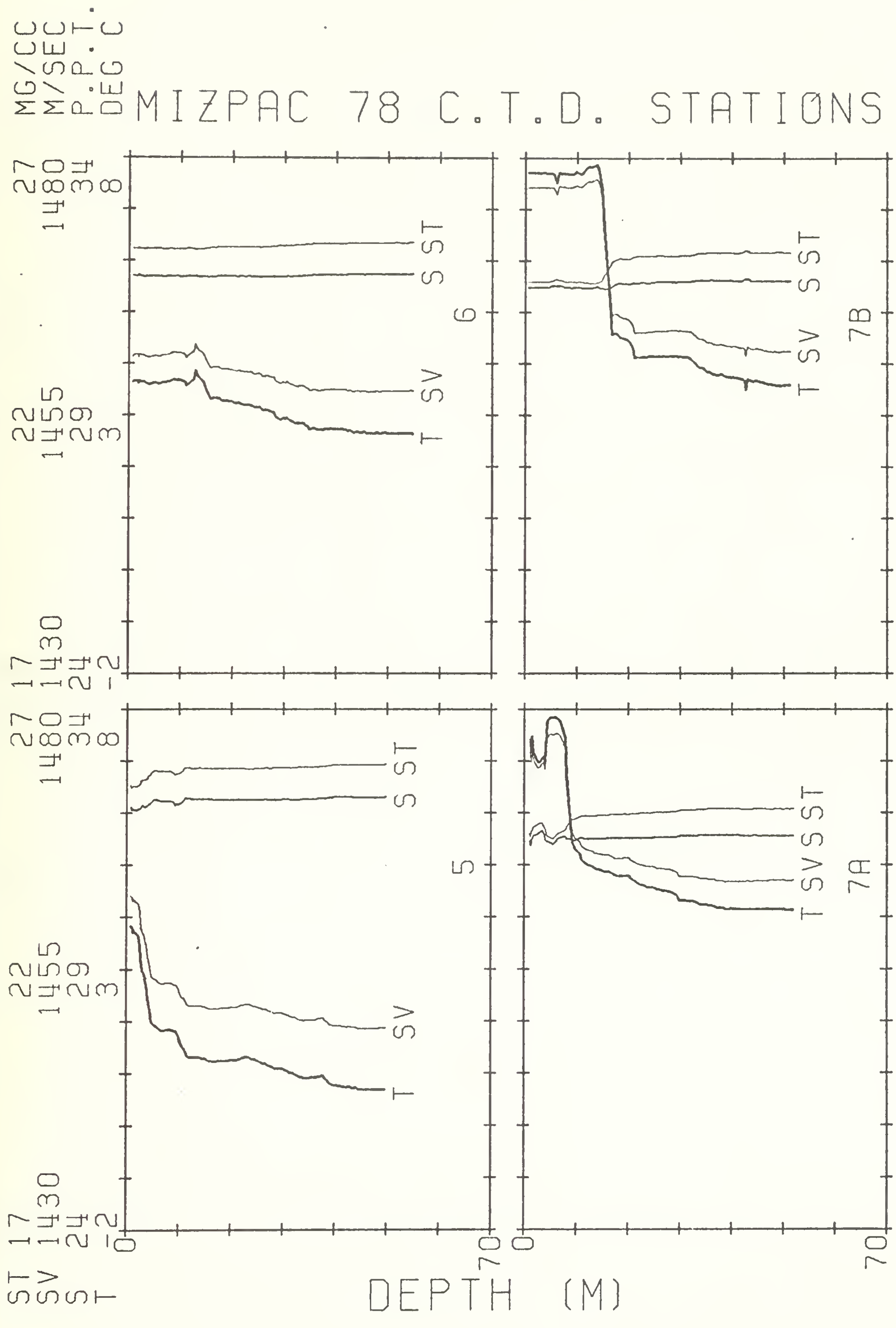
PROPERTY PROFILES FOR MIZPAC 78 STATIONS

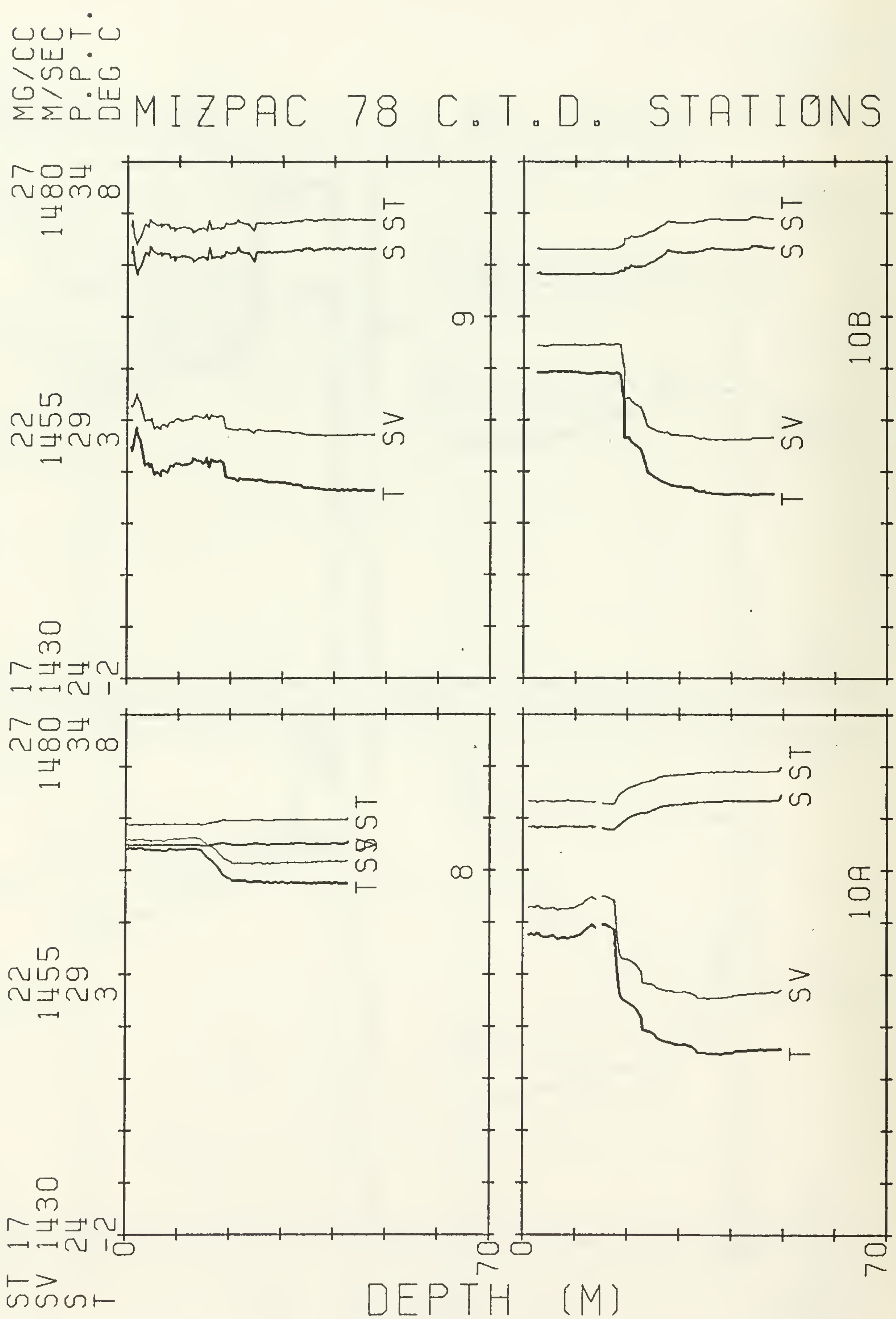
This section contains plots of temperature, salinity, sound velocity and sigma-t for all of the stations of MIZPAC 78 which were successfully recovered from the cassette tapes. Those stations taken from the ship are presented first; the helicopter stations follow. Station 55 is shown prematurely truncated while Stations 61, H-13 and H-14 are missing. The original plots made at sea are available for these four stations and were used where necessary to construct cross-sections. The effort to digitize these few stations did not appear warranted. The original plots of Stations H-16, 17, and 18 are slightly distorted in depth due to sensor problems, but are sufficiently acceptable for frontal and finestructure analysis. The CTD malfunctioned on Stations H-9 and H-10 providing no data for these stations. Replicate lowerings, e.g., Station 11A and 11B, were generally conducted to test the performance of a CTD which had malfunctioned. Four such stations are grouped together on the last page of the shipboard CTD plots. Stations 76, 90 and H-6 show both the down and up trace as there was some doubt as to the validity of the near-surface downward salinity profile.

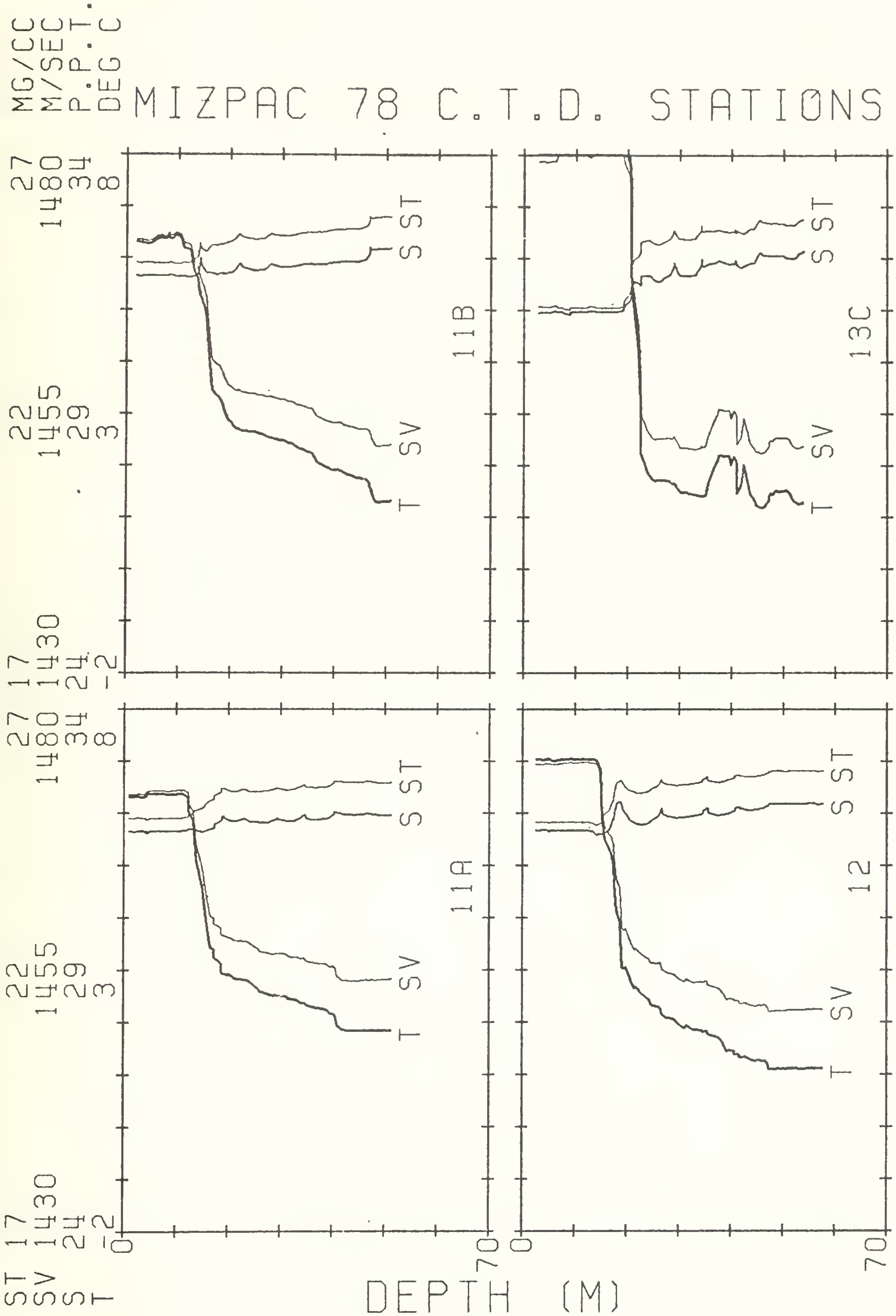
The basic four-per page plot has a maximum depth of 70 m. All stations were plotted in this way. In addition, deeper stations were plotted on a 140 m depth scale, two per page. These are interleaved sequentially with the smaller plots. To assist in distinguishing between curves the temperature has been darkened three times while the salinity trace only twice. The curves are also labeled, T for temperature, S for salinity, SV for sound velocity, and ST for sigma-t.

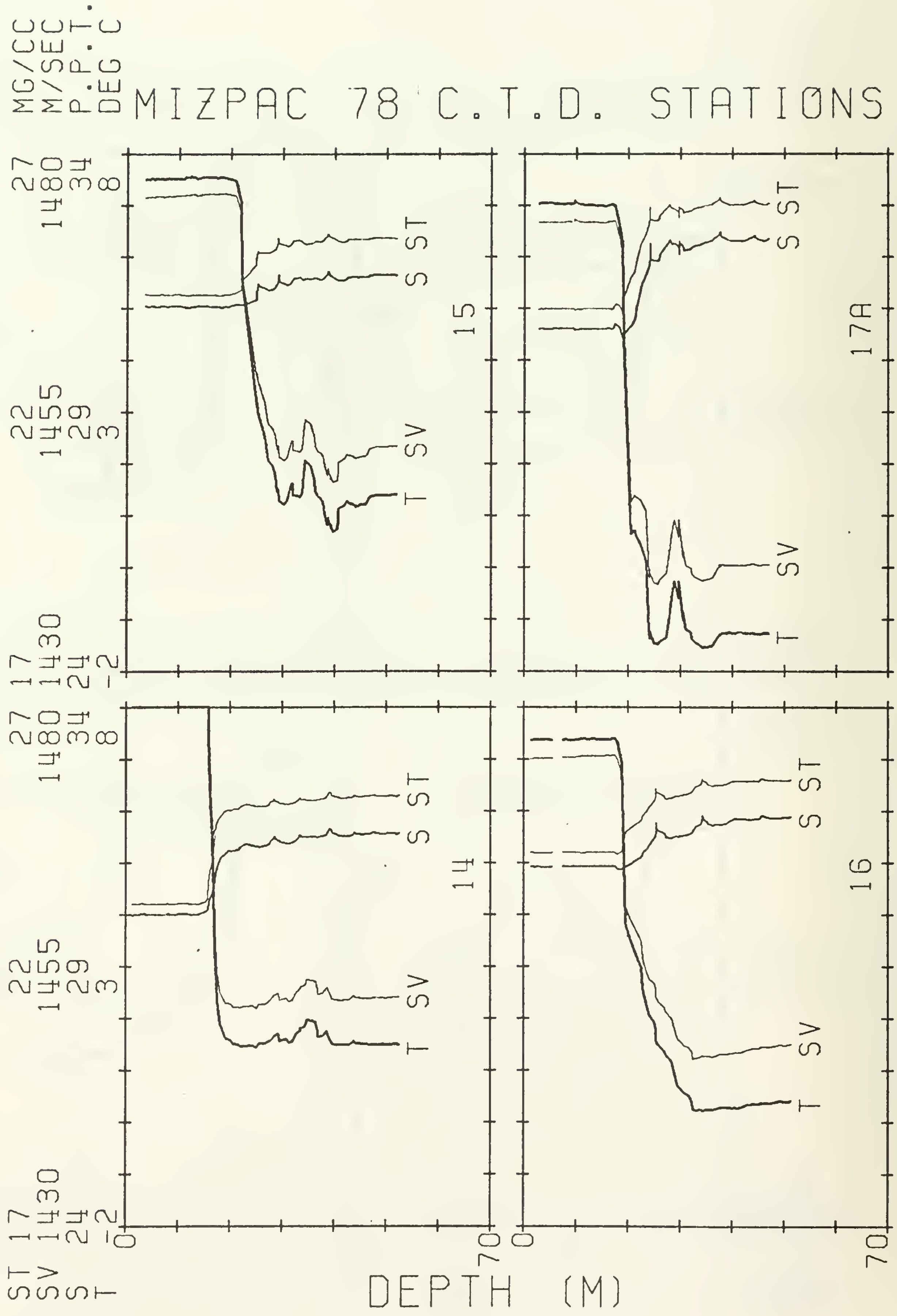


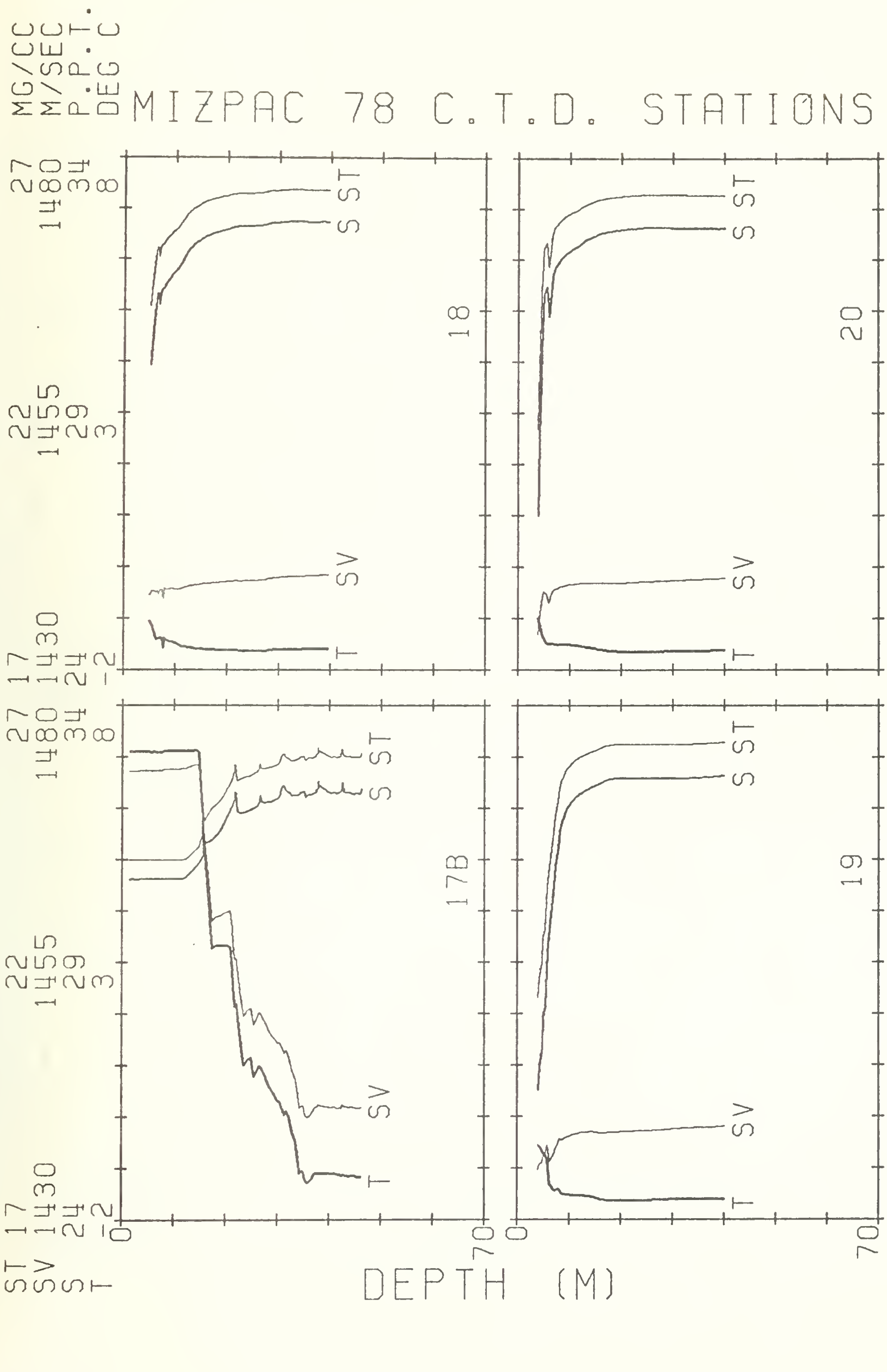
MG/CC
M/SEC
P.P.T.
DEG C
MIZPAC 78 C.T.D. STATIONS
27 1480 34 8
22 1455 29 3
17 1430 24 -2
ST
SV
S
T
T SV S ST
2
S ST
4
T SV
S
1
T SV S ST
3
0
70
DEPTH (M)

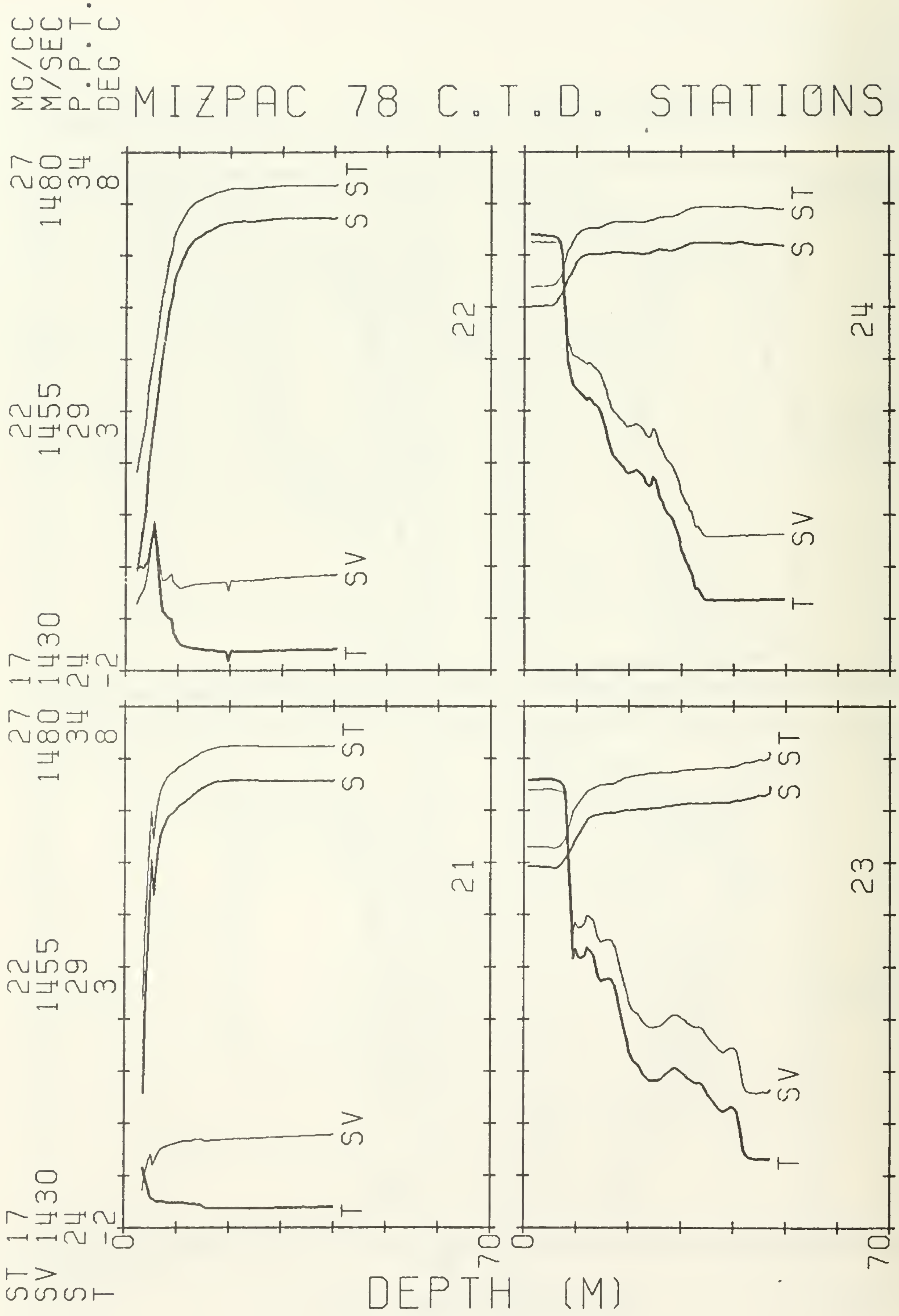

MIZPAC 78 C.T.D. STATIONS
ST SV S T
MG/CC M/SEC P.P.T. DEG.C
17 1430 24 -2
22 1455 29 3
27 1480 34 8
S ST
T SV
6
7B
5
7A
TSVSST
0
70
DEPTH (M)


MIZPAC 78 C.T.D. STATIONS
MG/CC
M/SEC
P.P.T.
DEG.C
ST SV S T
DEPTH (M)
SST
SV
T
9
10B
8
10A
TSSVSST
0
70
17 1430 24 -2
22 1455 29 3
27 1480 34 8

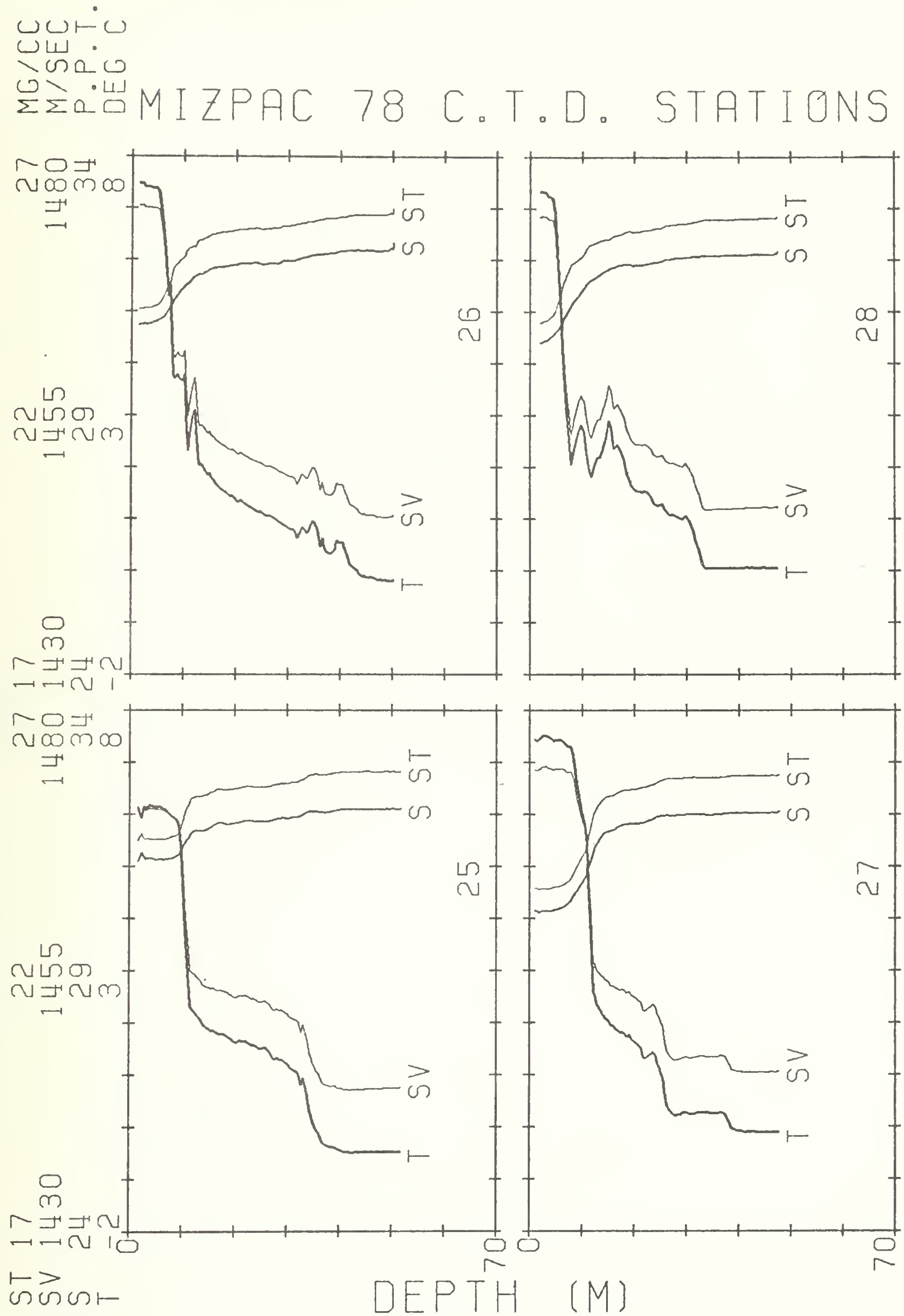

MIZPAC 78 C.T.D. STATIONS
MG/CC
M/SEC
P.P.T.
DEG.C
11B
13C
11A
12
S ST
SV
T
ST SV S T
17 1430 24 -2
22 1455 29 3
27 1480 34 8
0
70
DEPTH (M)

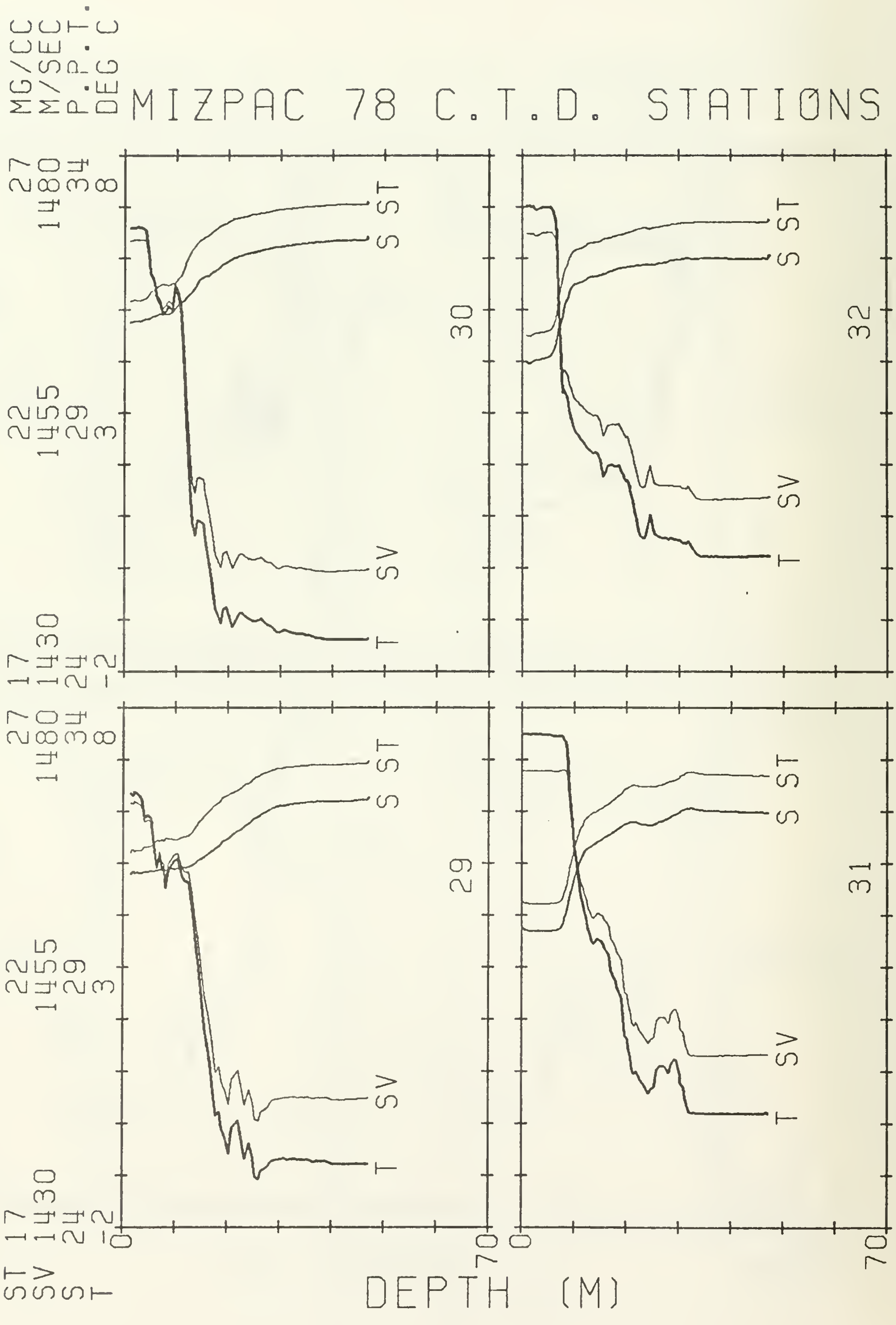

MIZPAC 78 C.T.D. STATIONS
ST MG/CC
SV M/SEC
S P.P.T.
T DEG.C
DEPTH (M)
15
17A
14
16
S ST
S
SV
T


MIZPAC 78 C.T.D. STATIONS
ST SV S T
MG/CC M/SEC P.P.T. DEG C
17 1430 24 -2
22 1455 29 3
27 1480 34 8
DEPTH (M)
0
70
18
20
17B
19
S ST
SV
T

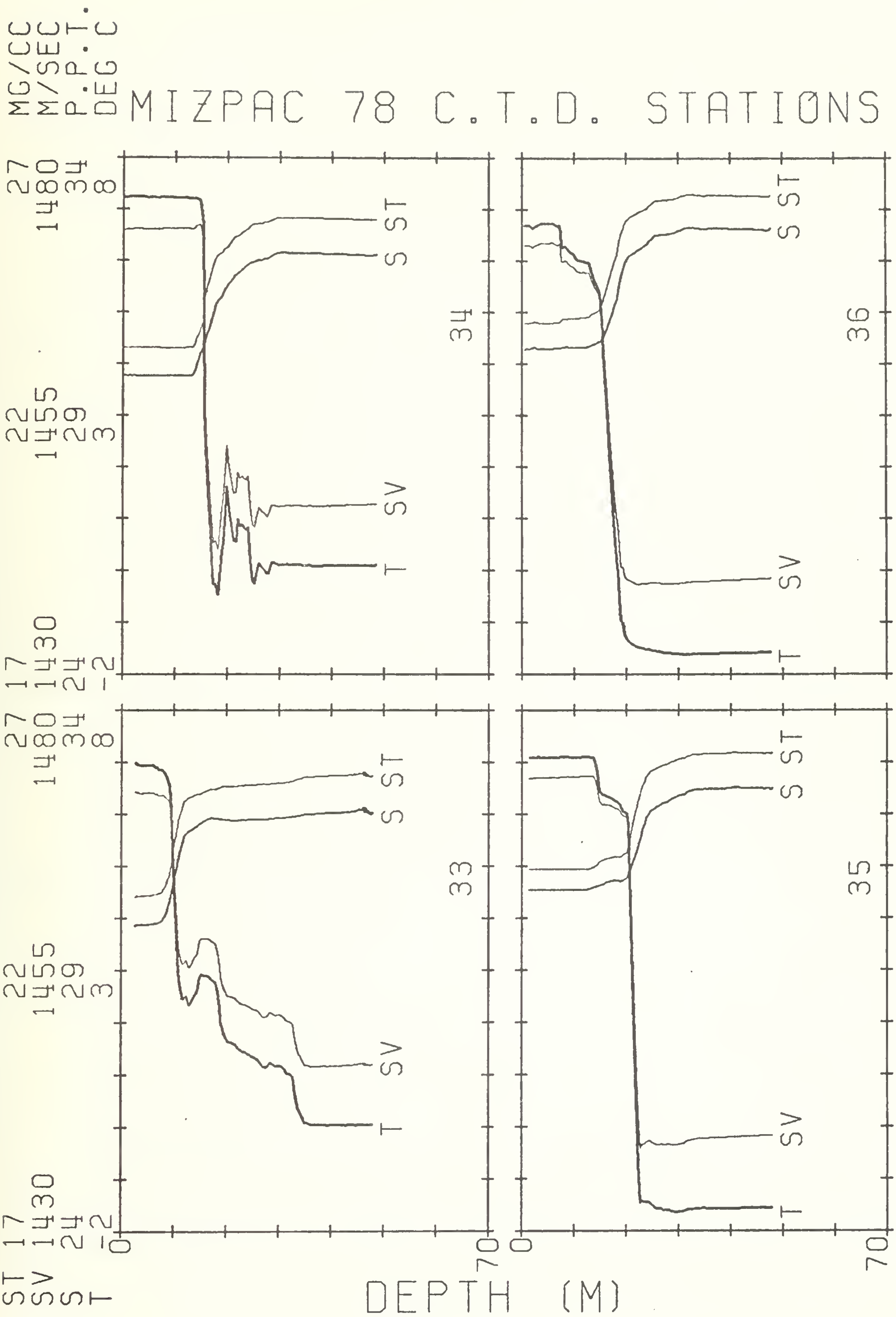


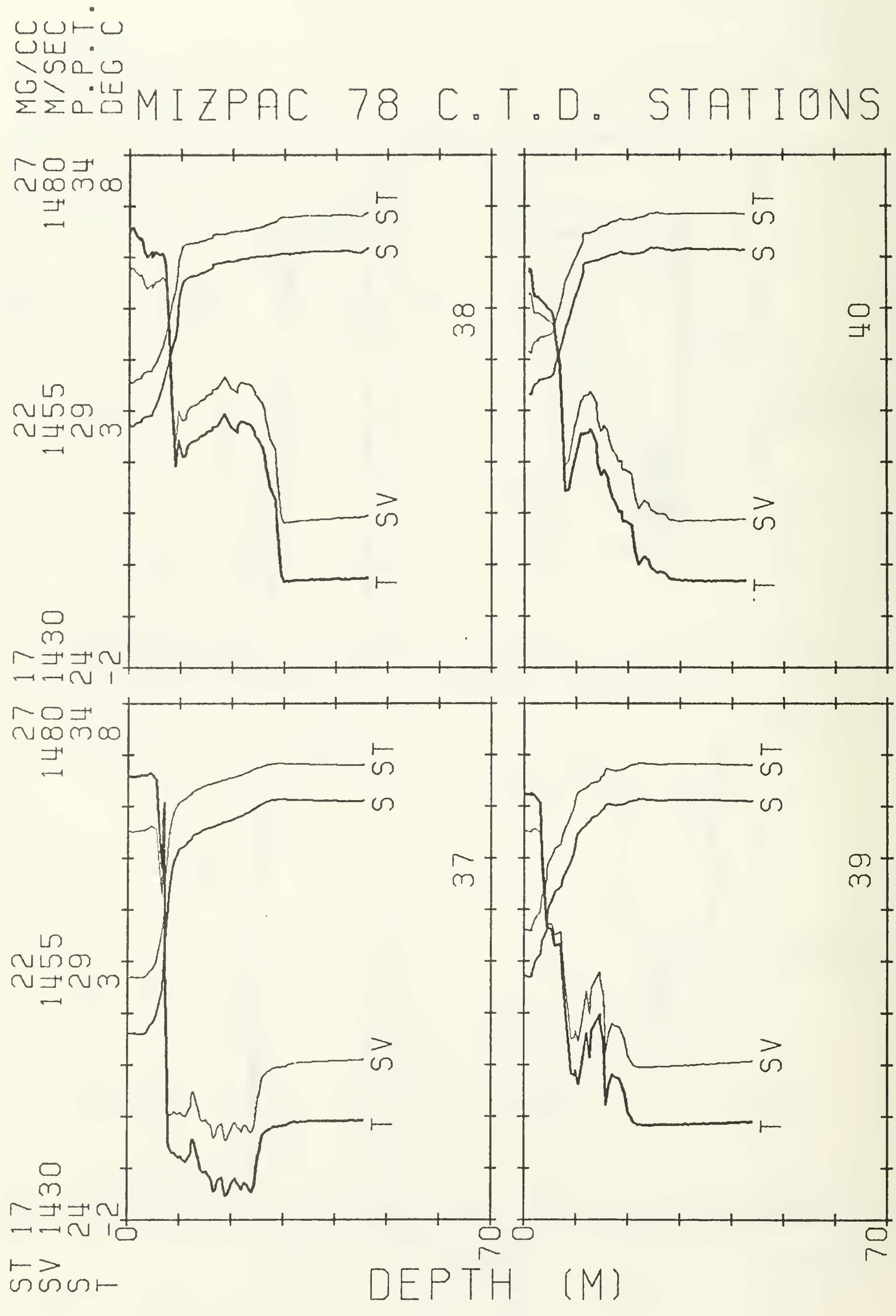
MIZPAC 78 C.T.D. STATIONS
ST MG/CC
SV M/SEC
S P.P.T.
T DEG C
17 1430 24 -2
22 1455 29 3
27 1480 34 8
22
24
21
23
S ST
S
SV
T
0
70
DEPTH (M)

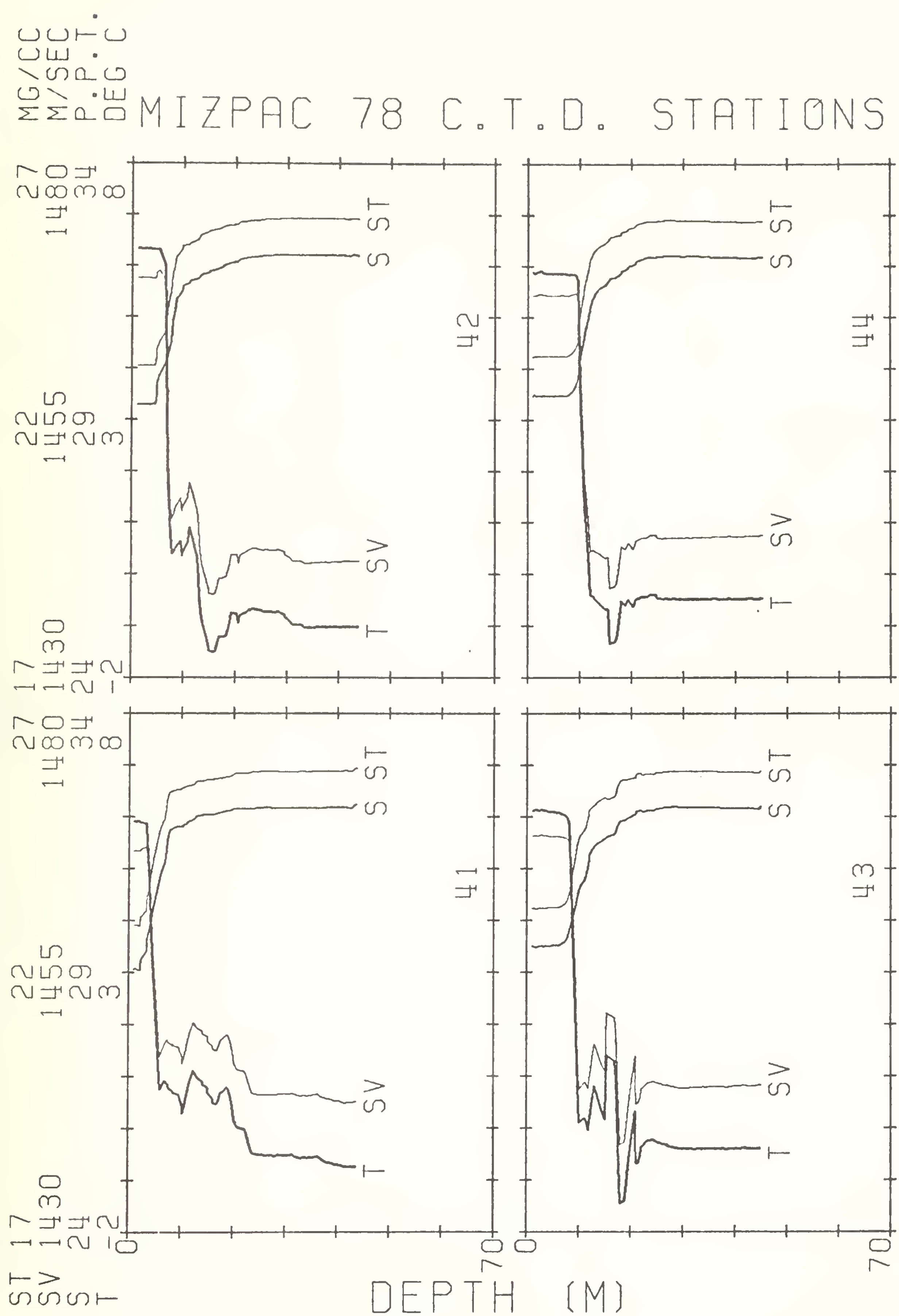

MIZPAC 78 C.T.D. STATIONS
MG/CC
M/SEC
P.P.T.
DEG C
ST
SV
S
T
17 1430 24 -2
22 1455 29 3
27 1480 34 8
26
28
25
27
S ST
SV
T
0
70
DEPTH (M)

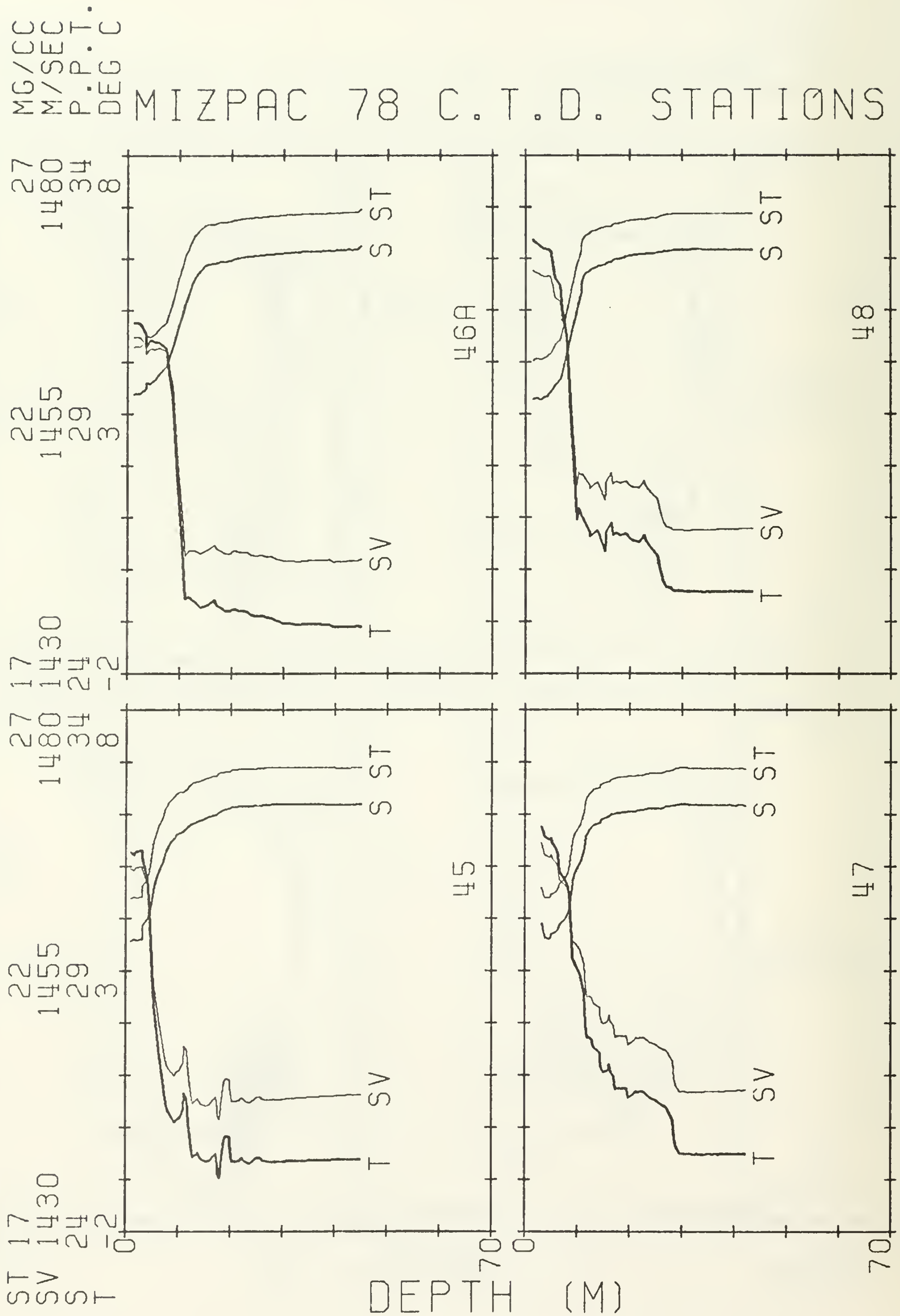


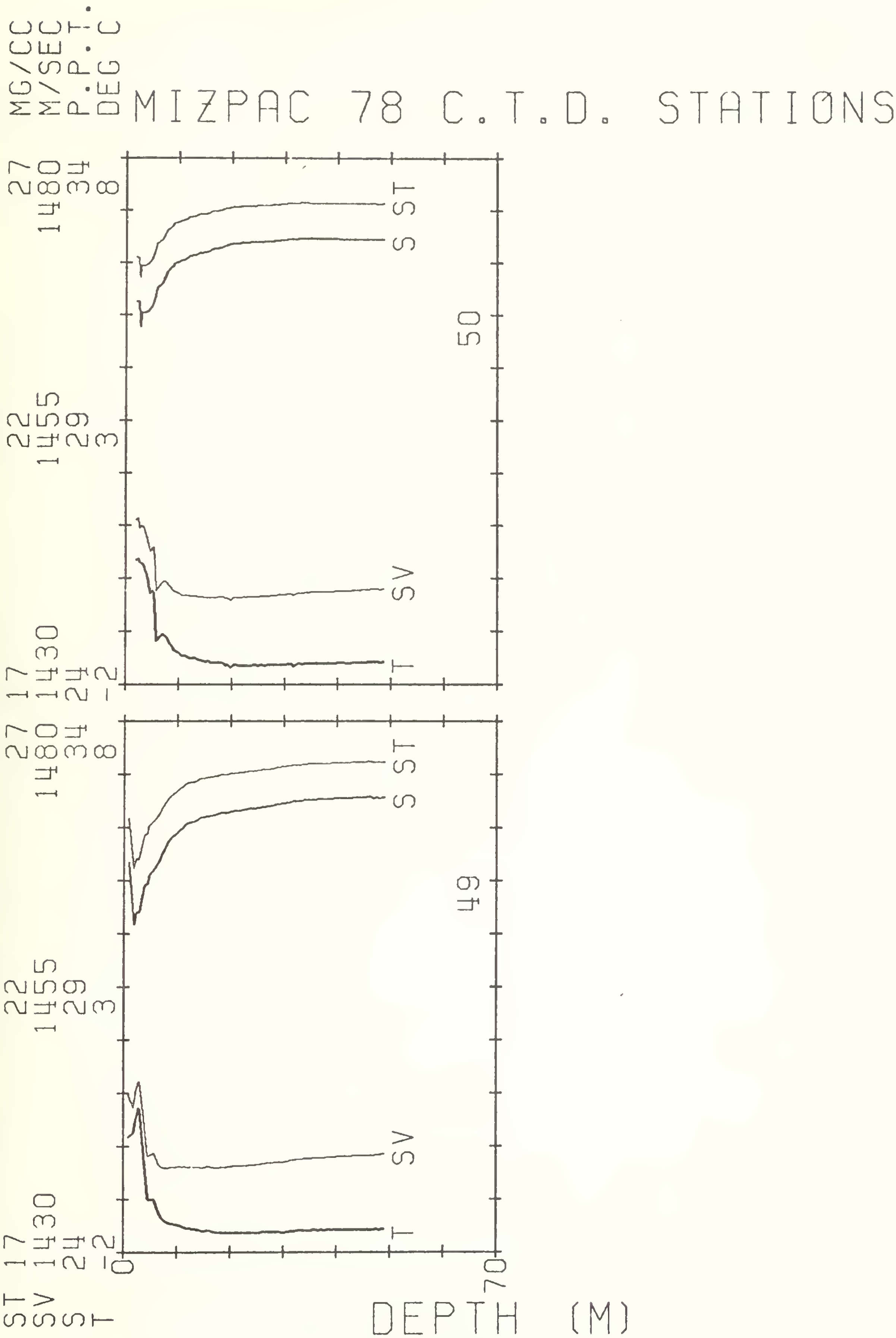
MIZPAC 78 C.T.D. STATIONS
MG/CC
M/SEC
P.P.T.
DEG.C
ST
SV
S
T
DEPTH (M)
30
32
29
31

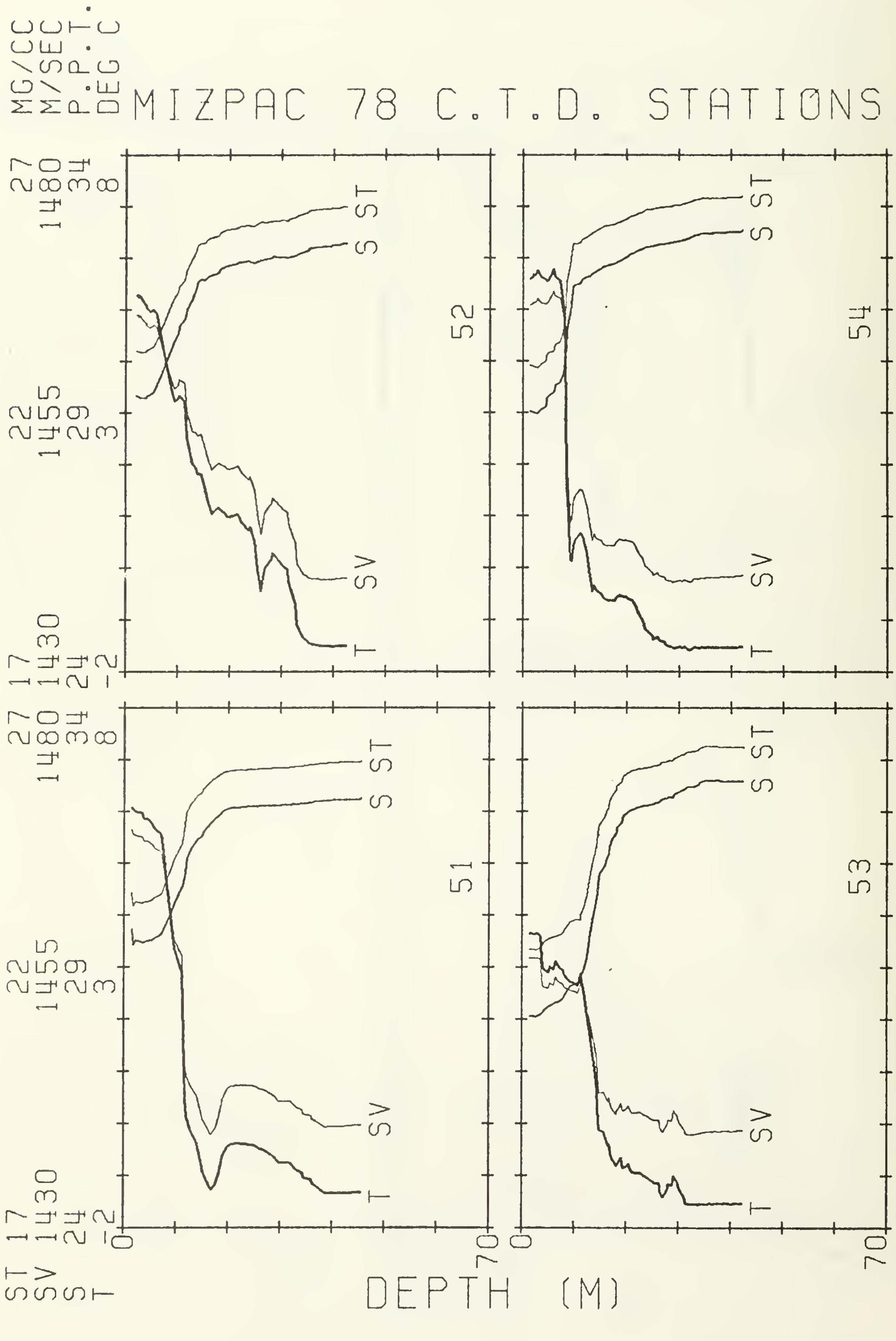

MIZPAC 78 C.T.D. STATIONS
MG/CC
M/SEC
P.P.T.
DEG C
ST
SV
S
T
17 22 27
1430 1455 1480
24 29 34
-2 3 8
34
36
33
35
S ST
SV
T
0
70
DEPTH (M)

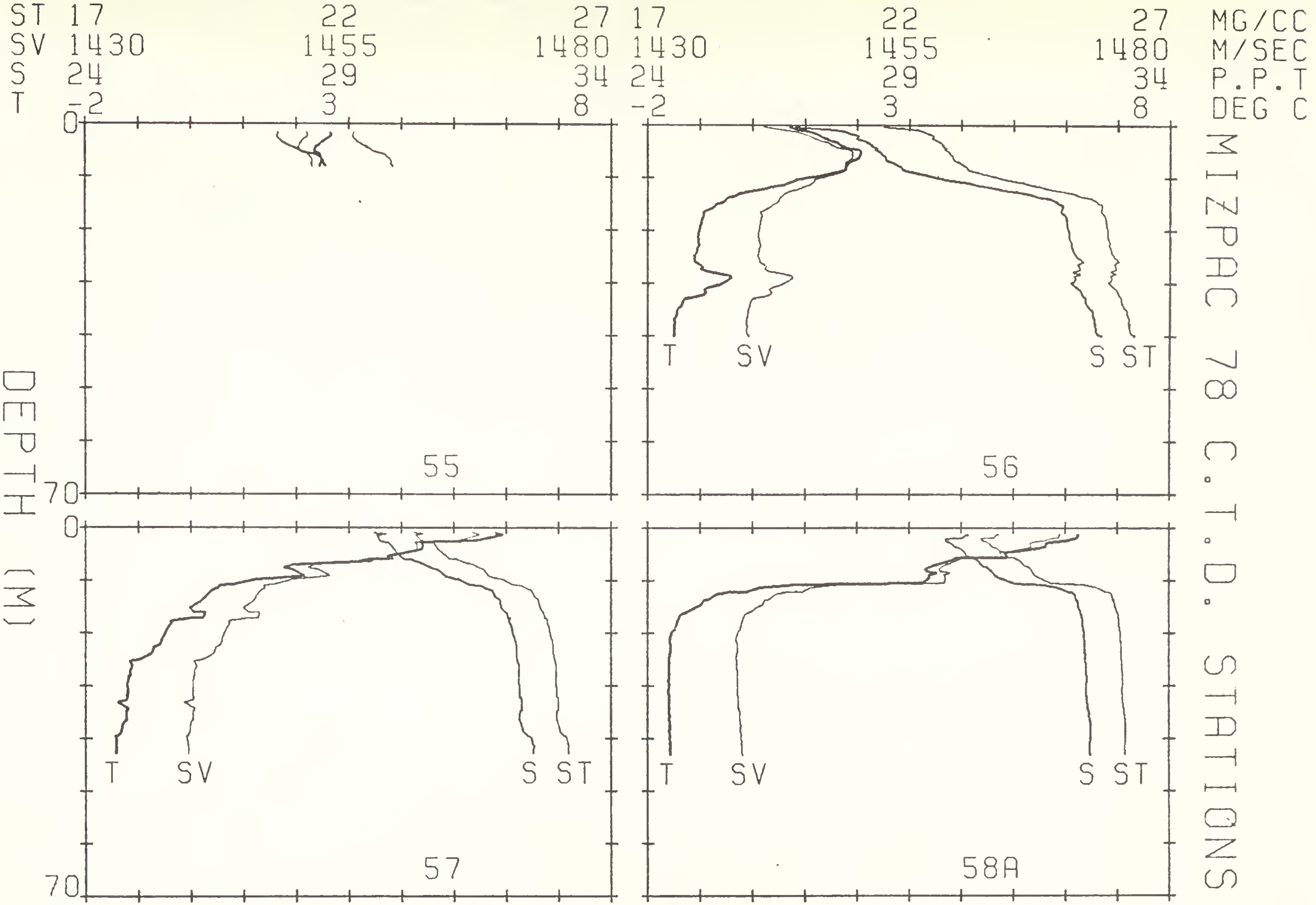

MIZPAC 78 C.T.D. STATIONS
MG/CC
M/SEC
P.P.T.
DEG C
ST 17 22 27
SV 1430 1455 1480
S 24 29 34
T -2 3 8
DEPTH (M)
0
70
37
38
39
40
S ST
S
SV
T

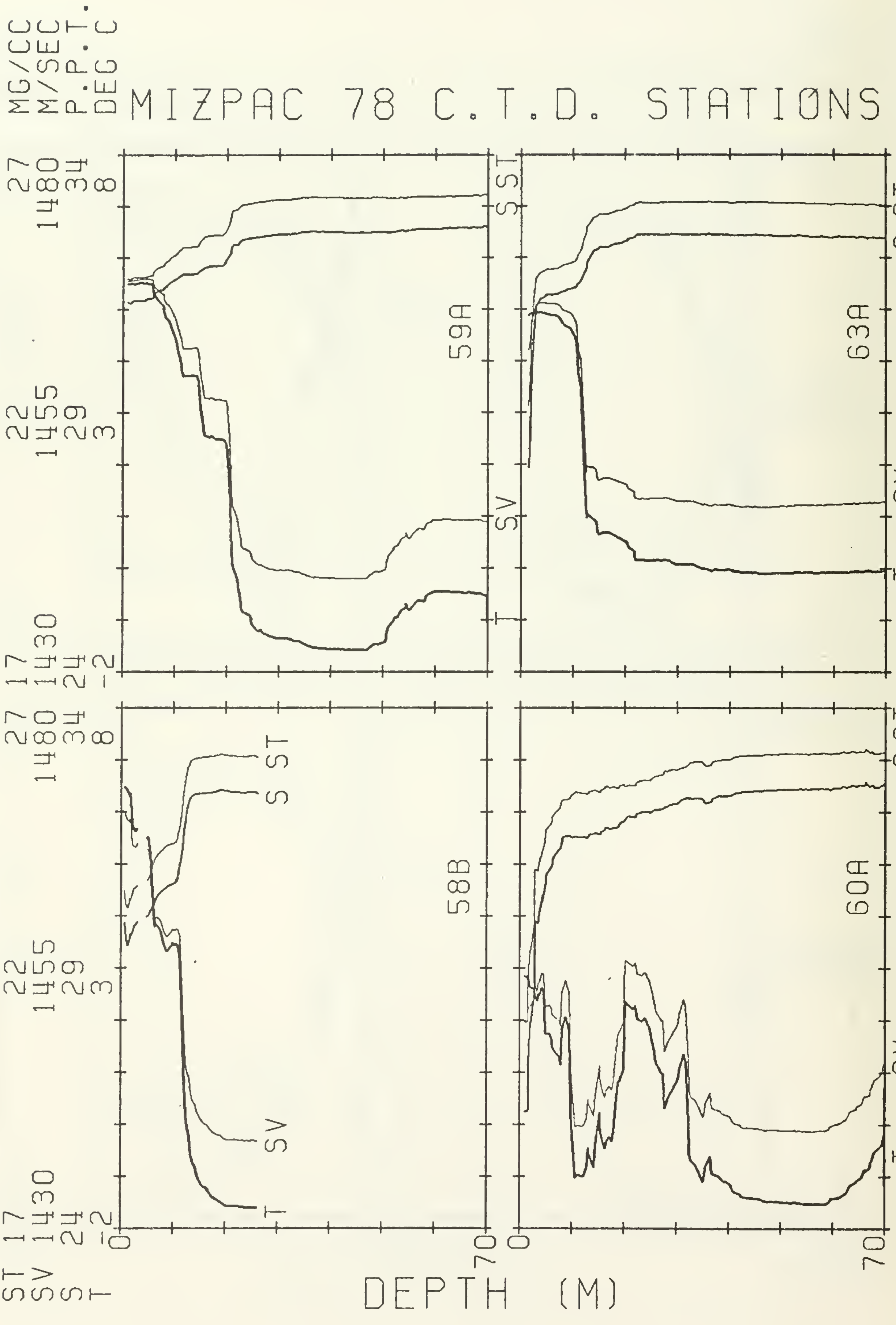

MIZPAC 78 C.T.D. STATIONS
ST MG/CC
SV M/SEC
S P.P.T.
T DEG C
17 1430 24 -2
22 1455 29 3
27 1480 34 8
DEPTH (M)
0
70
41
42
43
44
S ST
S
SV
T

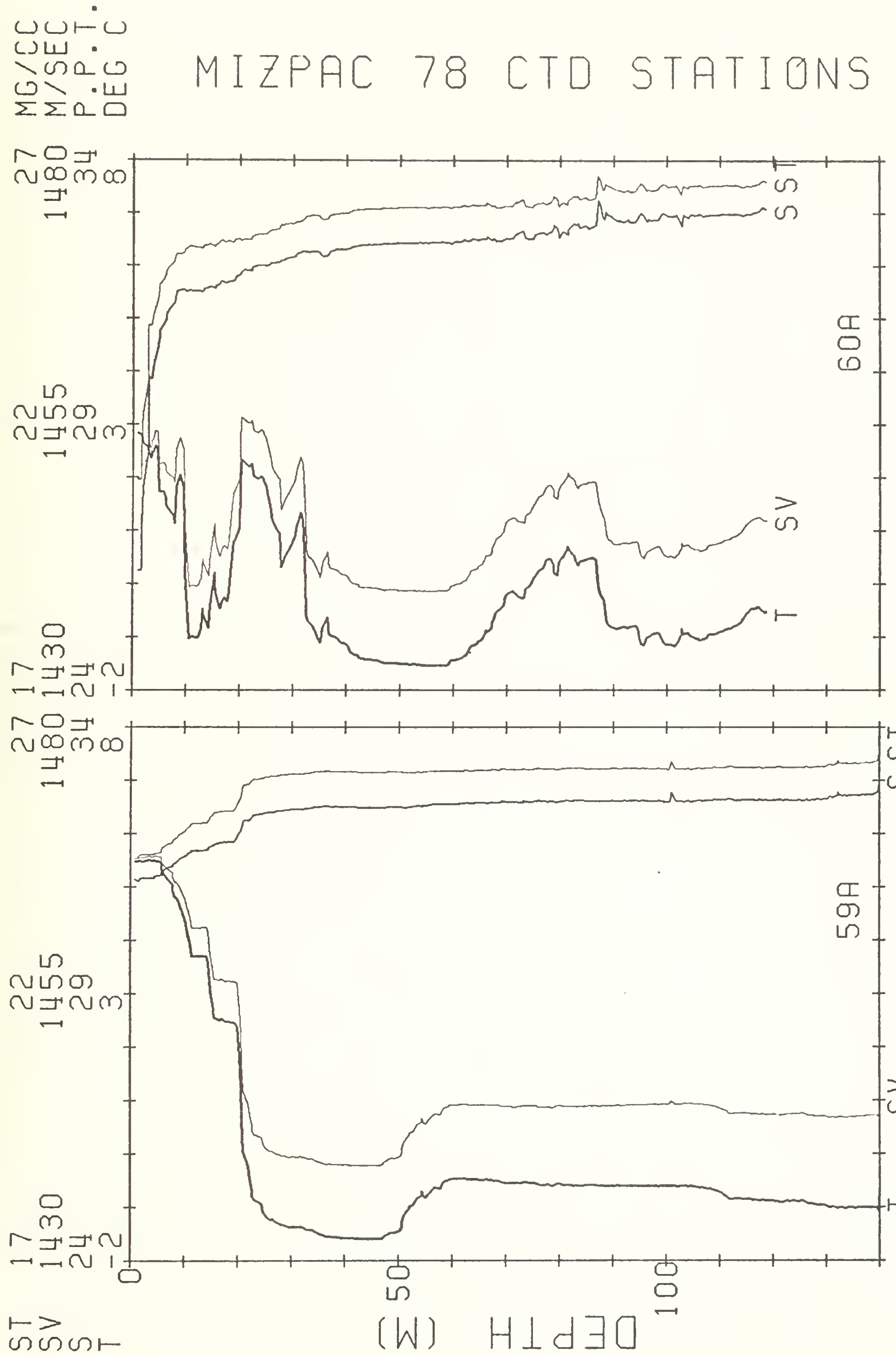

MIZPAC 78 C.T.D. STATIONS
46A
48
45
47
SV
T
S
ST
DEPTH (M)
0
70
ST 17 22 27 MG/CC
SV 1430 1455 1480 M/SEC
S 24 29 34 P.P.T.
T -2 3 8 DEG.C

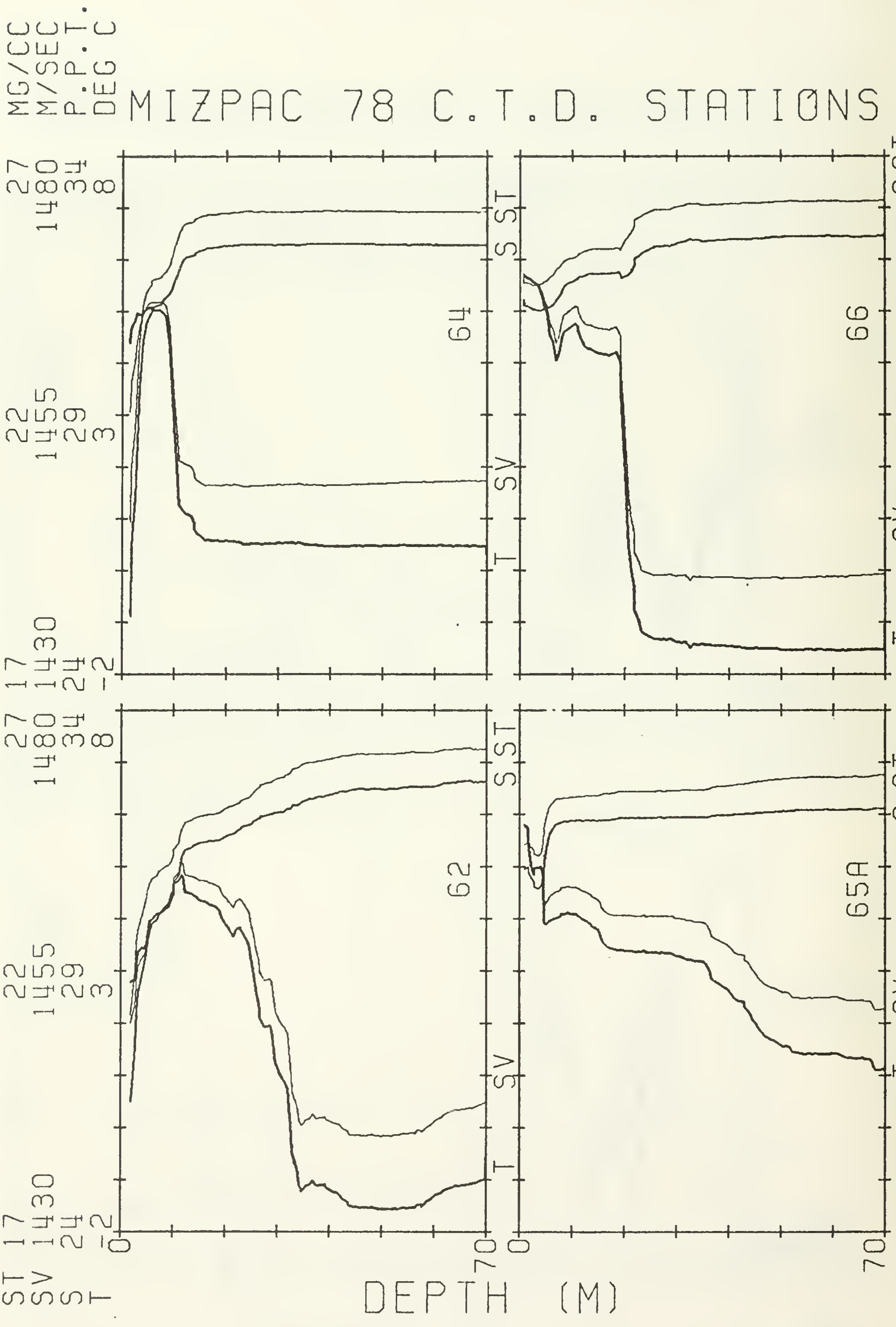

MIZPAC 78 C.T.D. STATIONS
MG/CC
M/SEC
P.P.T.
DEG C
27
1480
34
8
22
1455
29
3
17
1430
24
-2
S ST
S
SV
T
50
49
ST
SV
S
T
0
70
DEPTH (M)


MIZPAC 78 C.T.D. STATIONS
MG/CC
M/SEC
P.P.T.
DEG C
ST SV S T
DEPTH (M)
0
70
17 1430 24 -2
22 1455 29 3
27 1480 34 8
51
52
53
54
S ST
S
SV
T

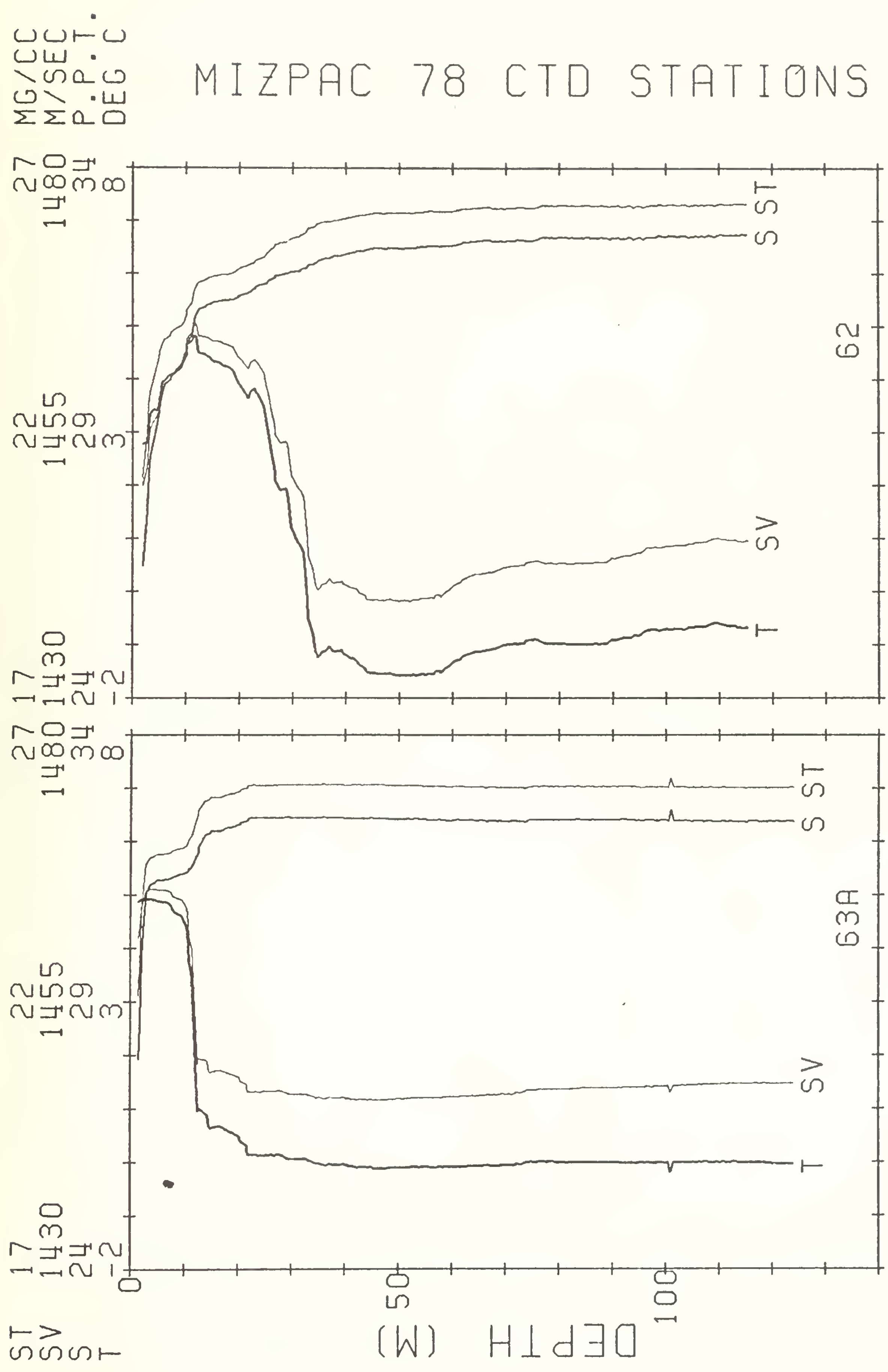

MIZPAC 78 C.T.D. STATIONS
ST 17 22 27 MG/CC
SV 1430 1455 1480 M/SEC
S 24 29 34 P.P.T.
T -2 3 8 DEG C
DEPTH (M)
0
70
55
56
57
58A
T
SV
S
ST

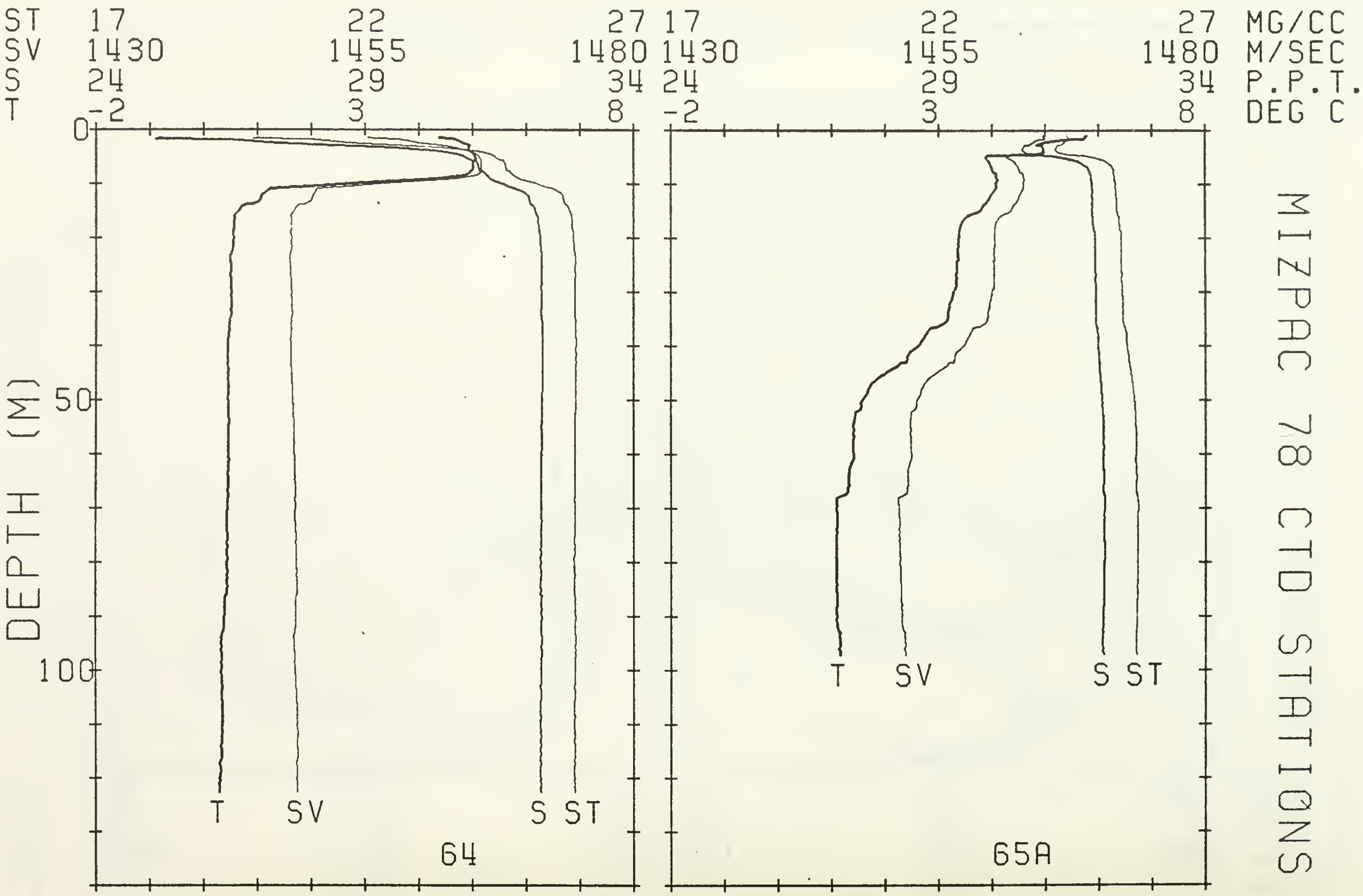

MIZPAC 78 C.T.D. STATIONS
MG/CC
M/SEC
P.P.T.
DEG C
59A
63A
58B
60A
S
ST
SV
T
DEPTH (M)
0
70


MIZPAC 78 CTD STATIONS
ST SV S T
27 1480 34 8
22 1455 29 3
17 1430 24 -2
MG/CC M/SEC P.P.T. DEG C
60A
59A
SST
SV
T
DEPTH (M)
0
50
100

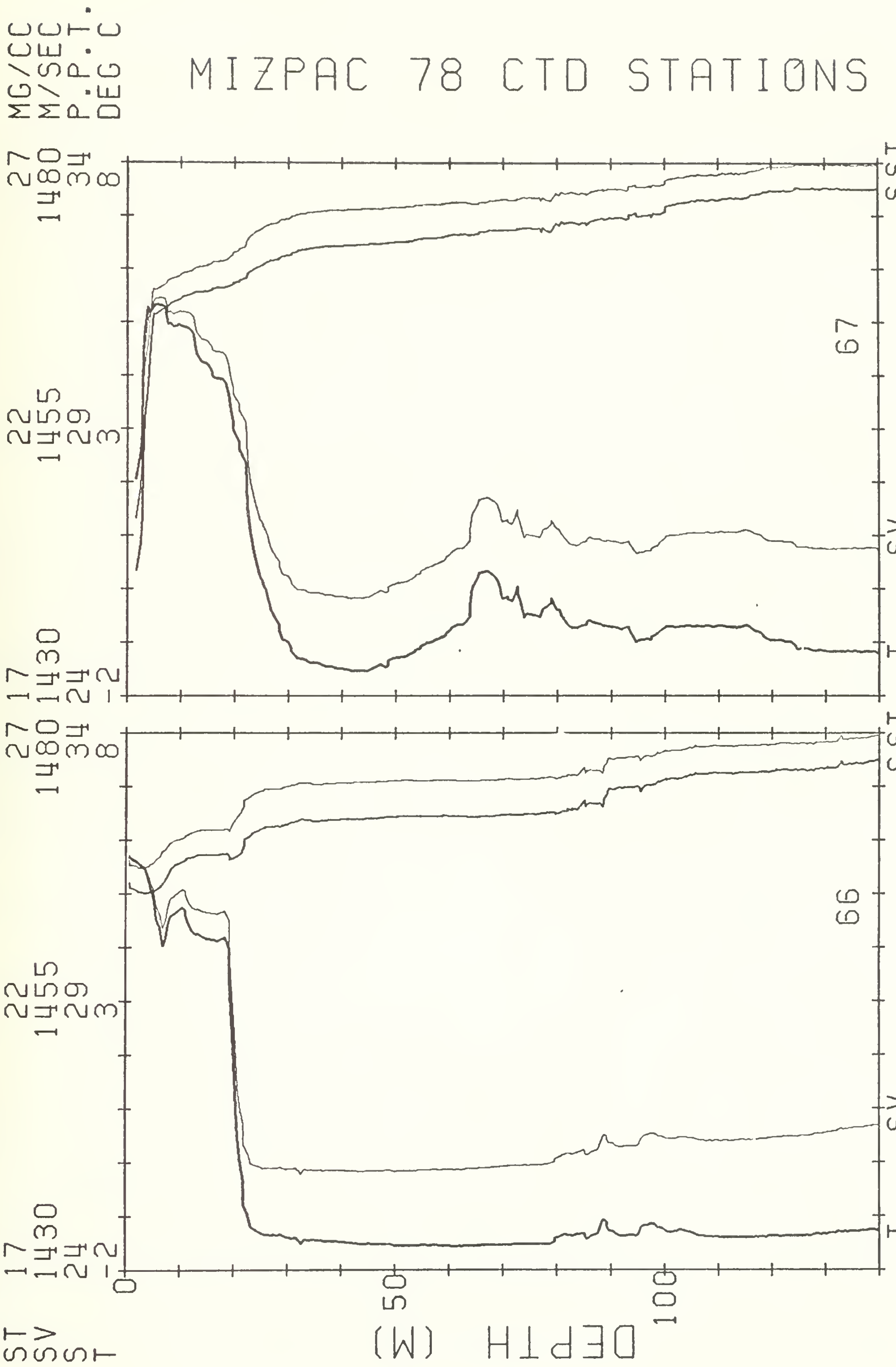

MIZPAC 78 C.T.D. STATIONS
MG/CC
M/SEC
P.P.T.
DEG C
ST SV S T
27 1480 34 8
22 1455 29 3
17 1430 24 -2
64
66
62
65A
SST
SV
T
DEPTH (M)
0
70

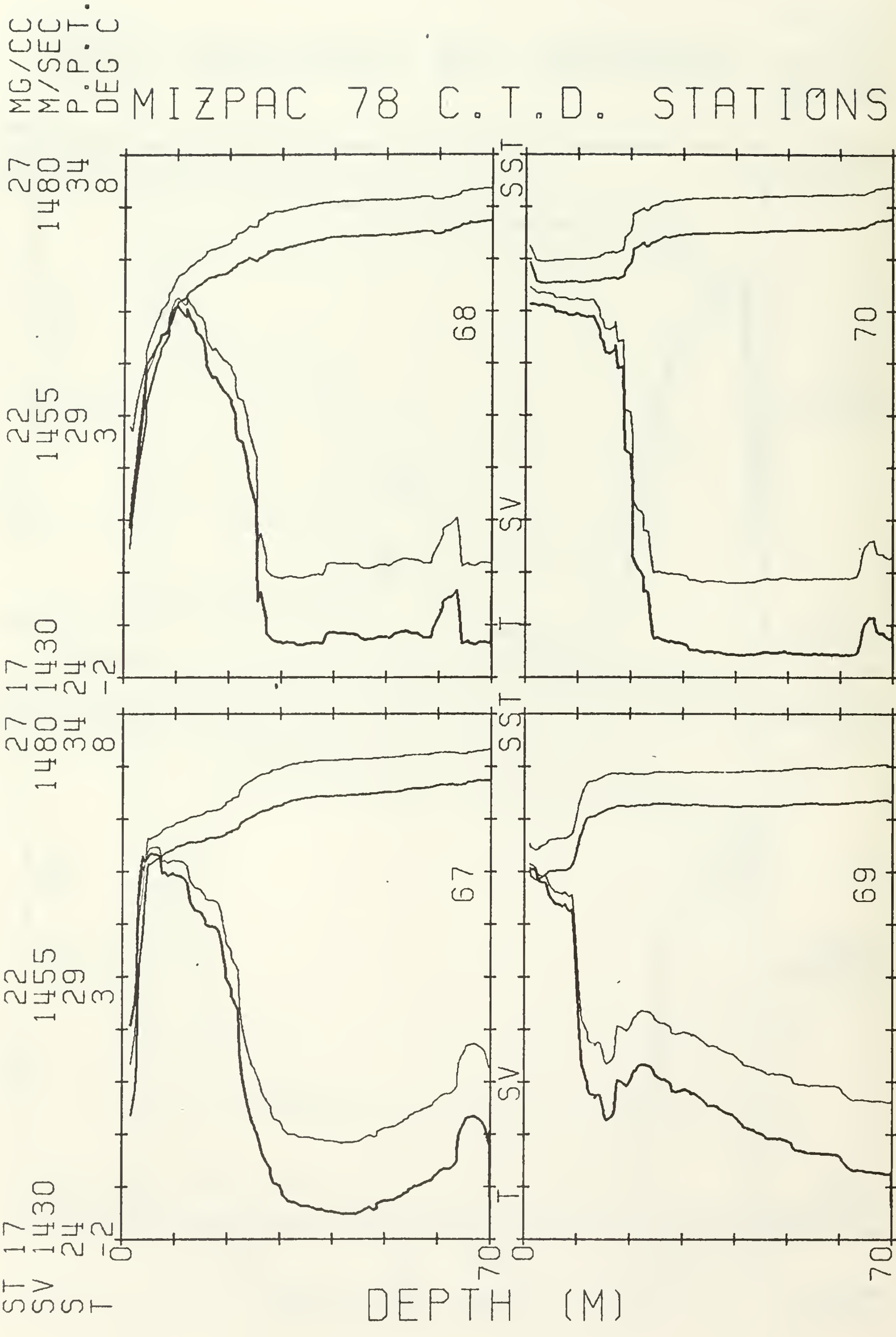
MIZPAC 78 CTD STATIONS

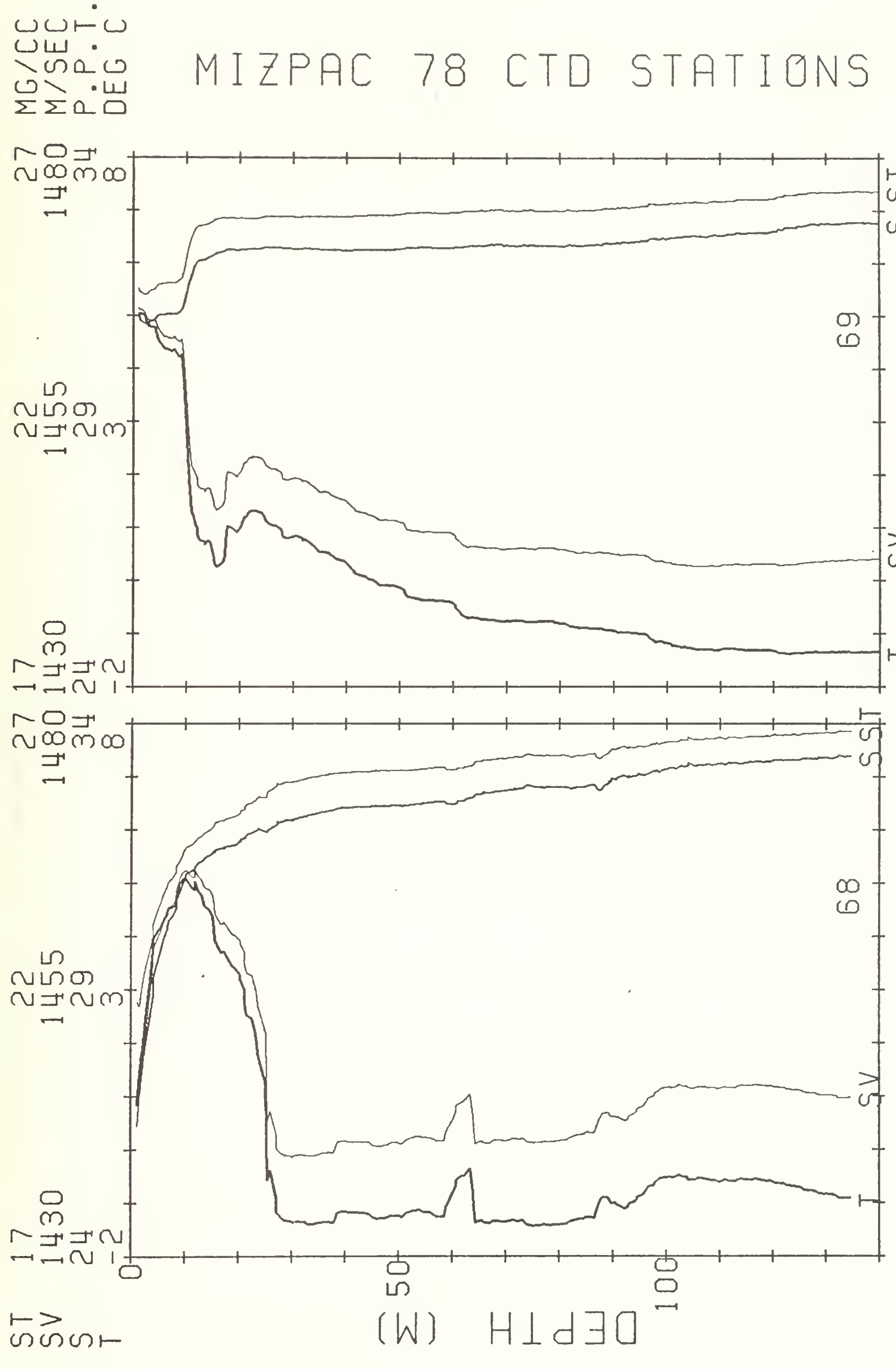


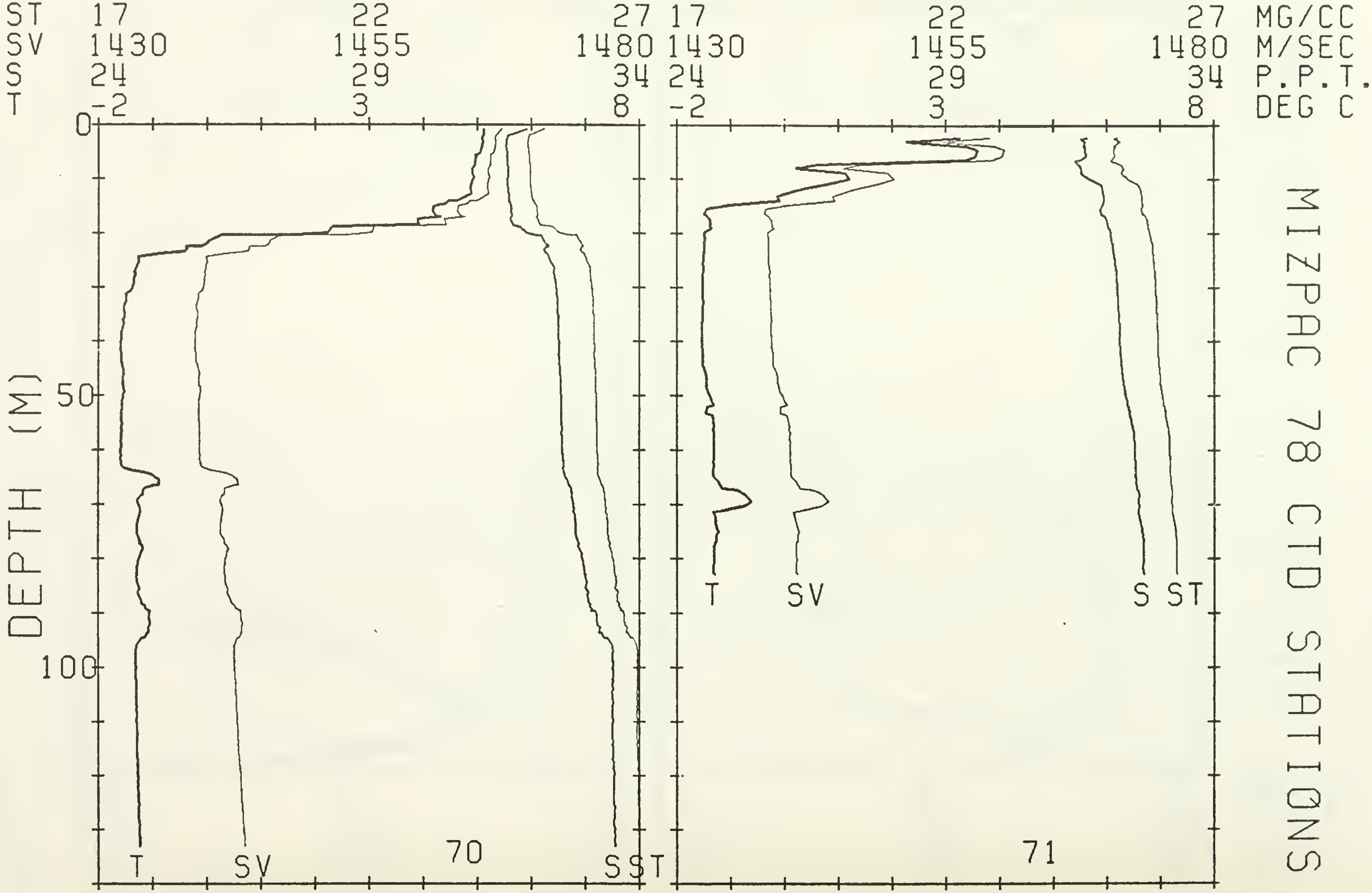


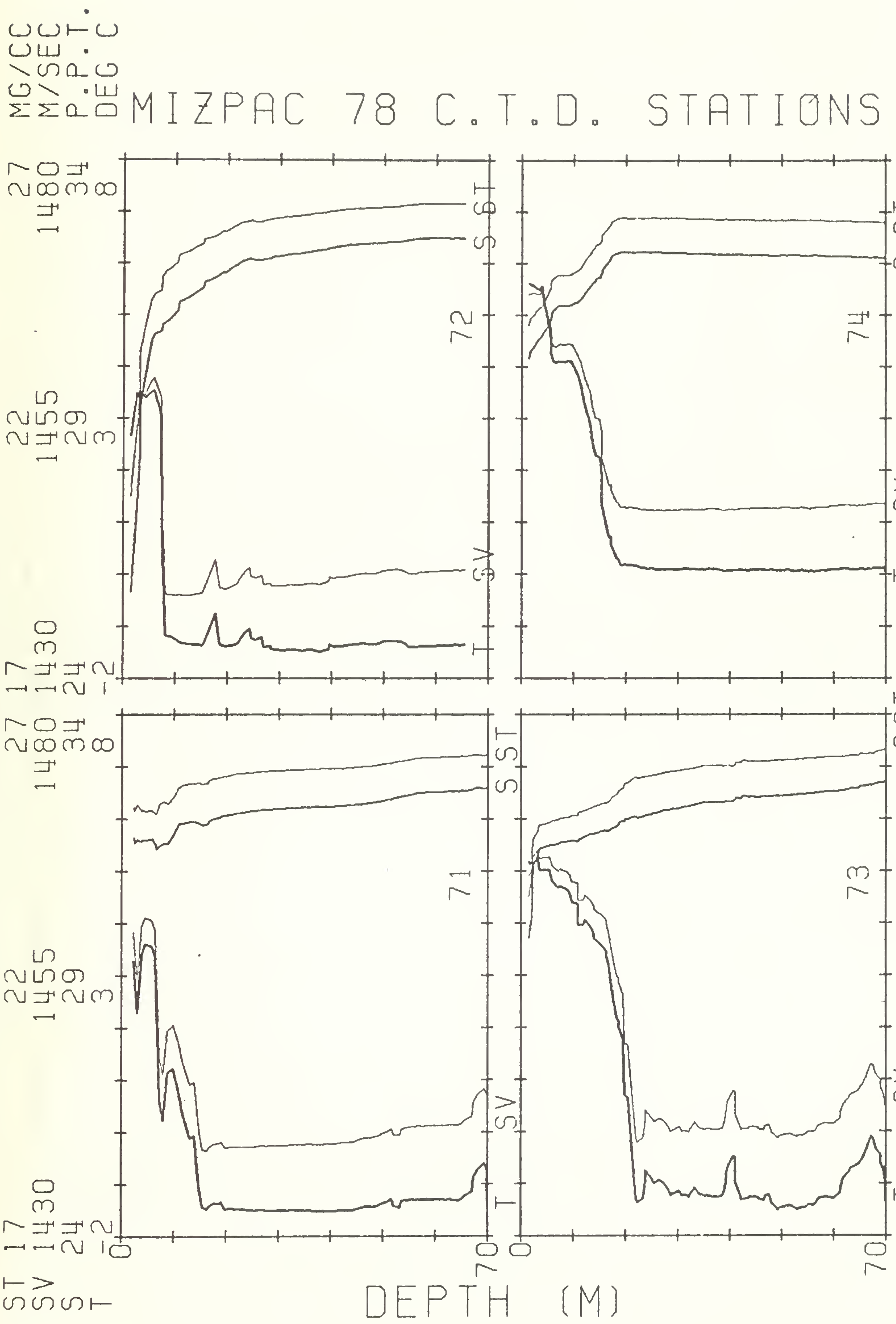
MIZPAC 78 CTD STATIONS
ST 17 22 27 MG/CC
SV 1430 1455 1480 M/SEC
S 24 29 34 P.P.T.
T -2 3 8 DEG C
DEPTH (M)
0
50
100
T SV S ST
64
65A

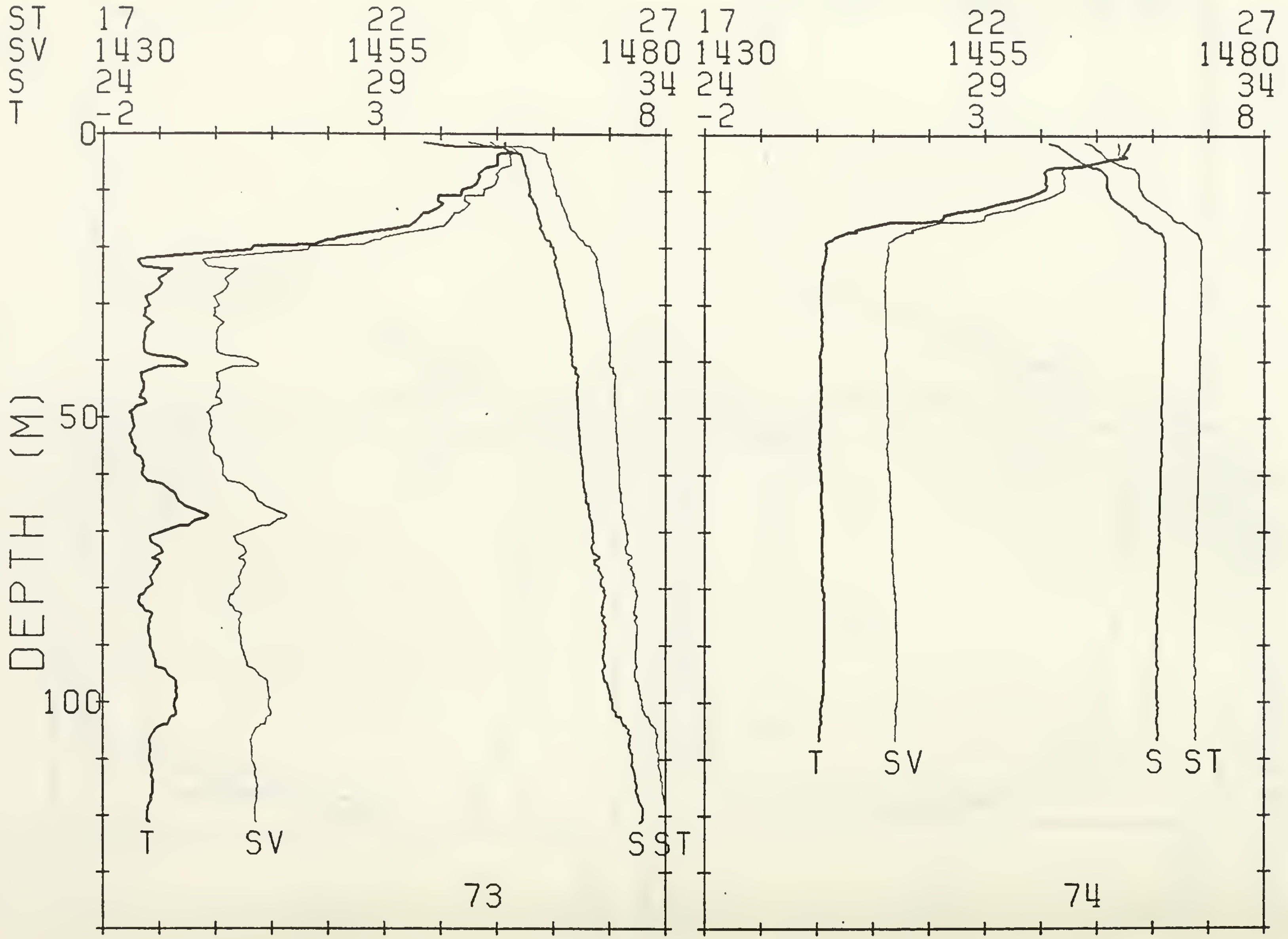

MIZPAC 78 CTD STATIONS
27 MG/CC
1480 M/SEC
34 P.P.T.
8 DEG C
22
1455
29
3
17
1430
24
-2
ST
SV
ST
67
66
SST
SV
T
DEPTH (M)
0
50
100


MIZPAC 78 C.T.D. STATIONS
MG/CC
M/SEC
P.P.T.
DEG C
27 1480 34 8
22 1455 29 3
17 1430 24 -2
ST SV S T
68
70
67
69
S ST
SV
T
0
70
DEPTH (M)

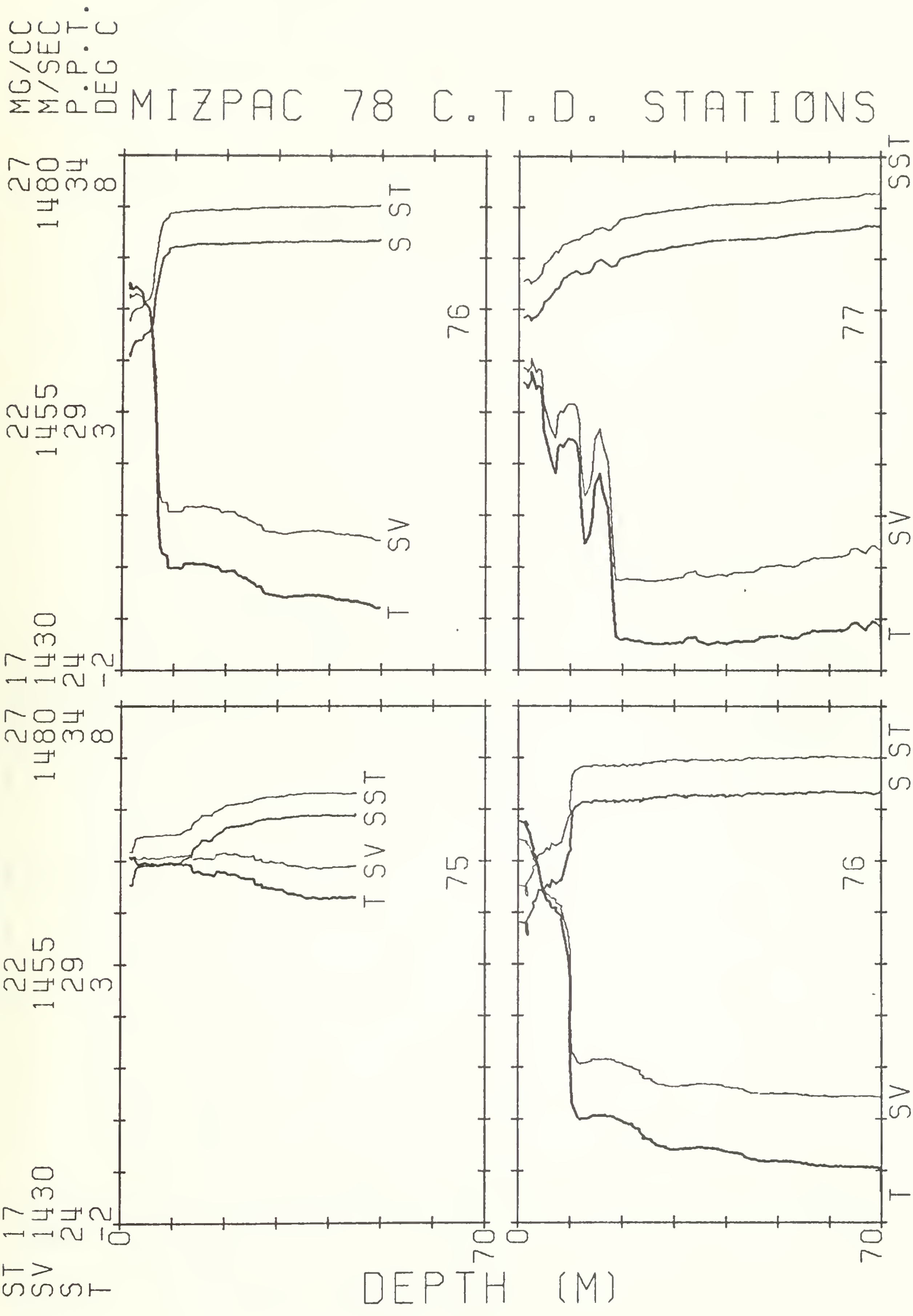

MIZPAC 78 CTD STATIONS
27 MG/CC
1480 M/SEC
34 P.P.T.
8 DEG C
22
1455
29
3
17
1430
24
-2
69
68
S ST
SV
T
ST
SV
S
T
0
50
100
DEPTH (M)

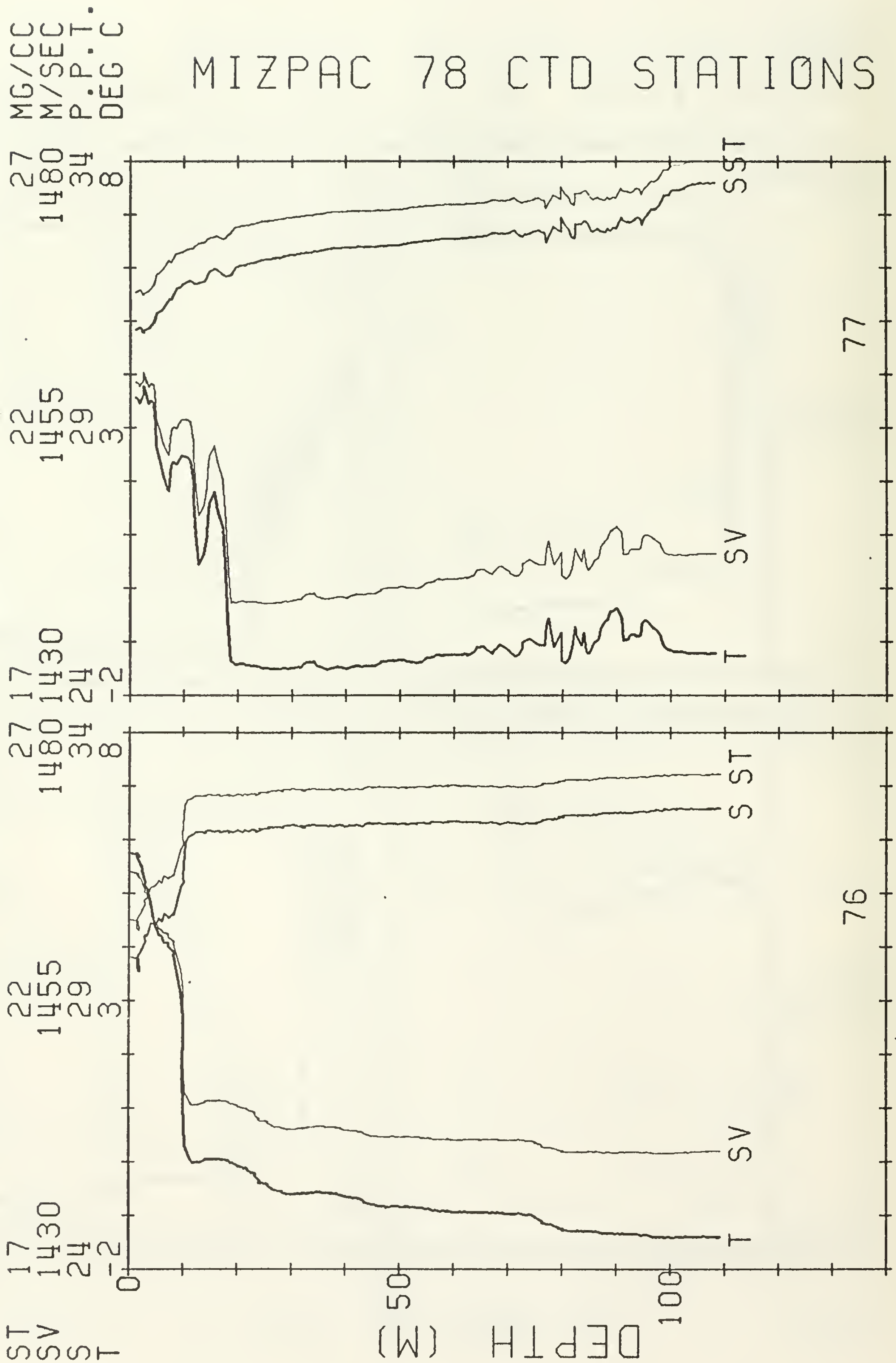

MIZPAC 78 CTD STATIONS
ST SV S T
17 1430 24 -2
22 1455 29 3
27 1480 34 8
MG/CC M/SEC P.P.T. DEG C
DEPTH (M)
0
50
100
T SV S ST
70
71


MIZPAC 78 C.T.D. STATIONS
MG/CC
M/SEC
P.P.T.
DEG C
ST
SV
S
T
72
74
71
73
DEPTH (M)

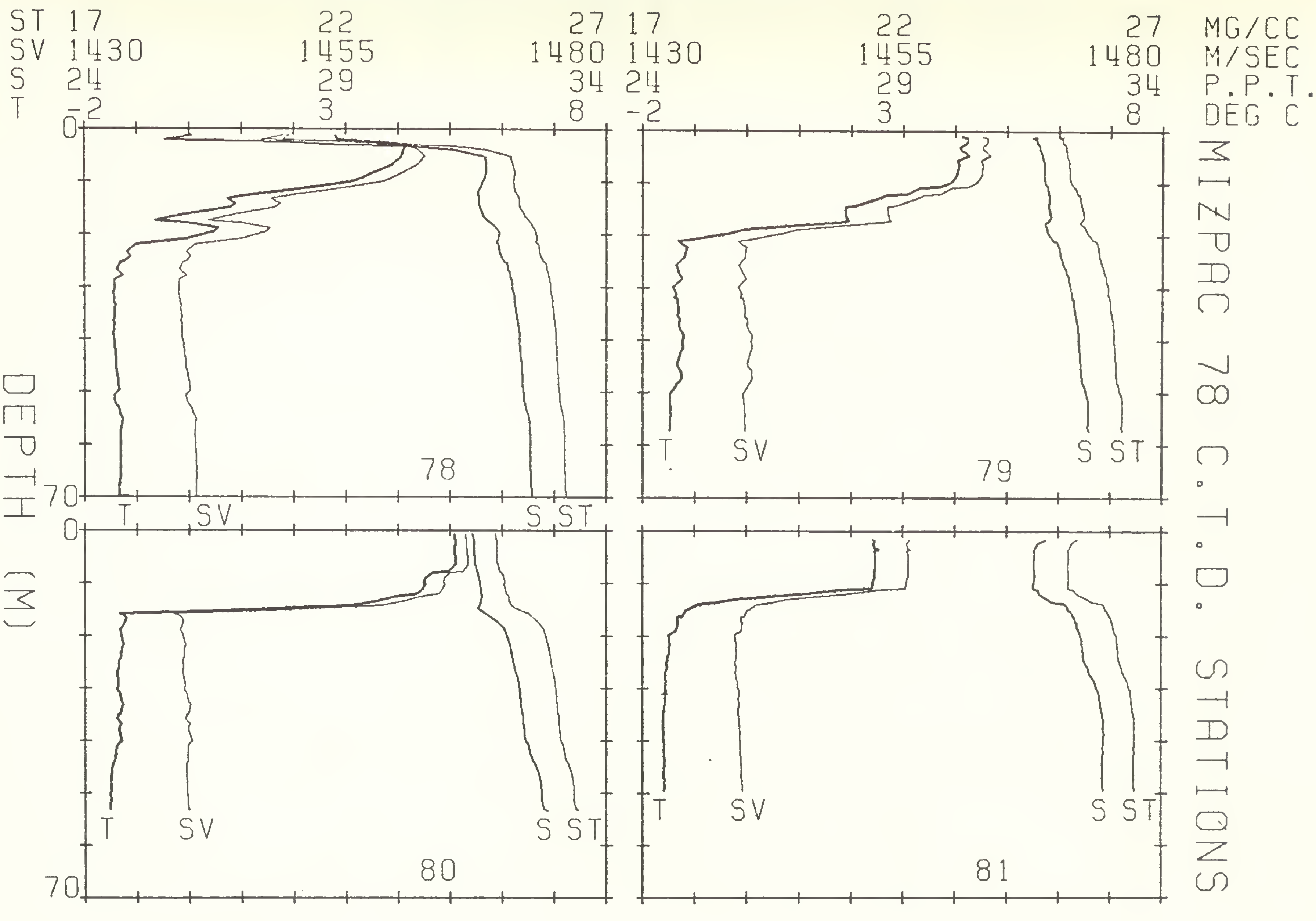


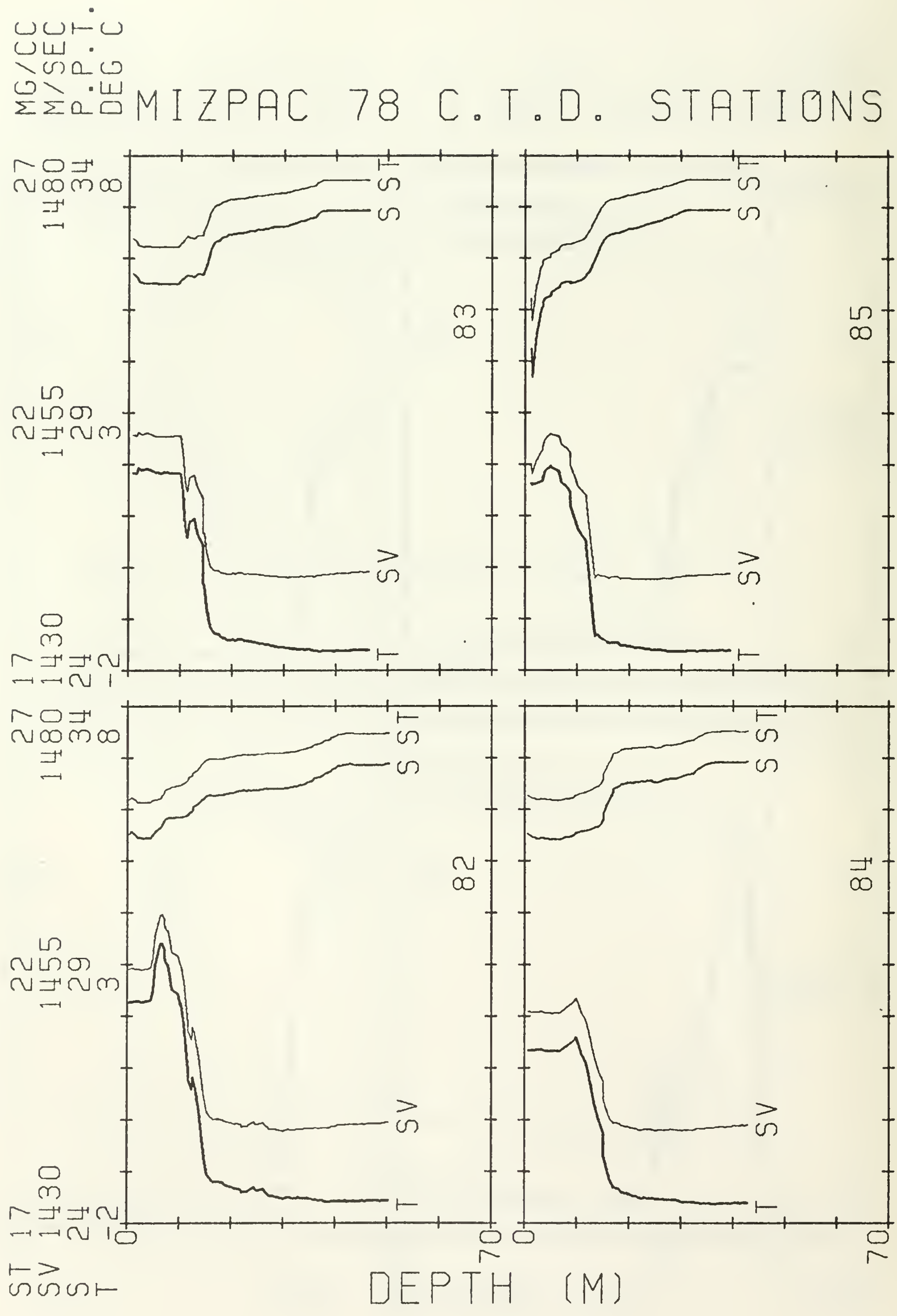
MIZPAC 78 CTD STATIONS

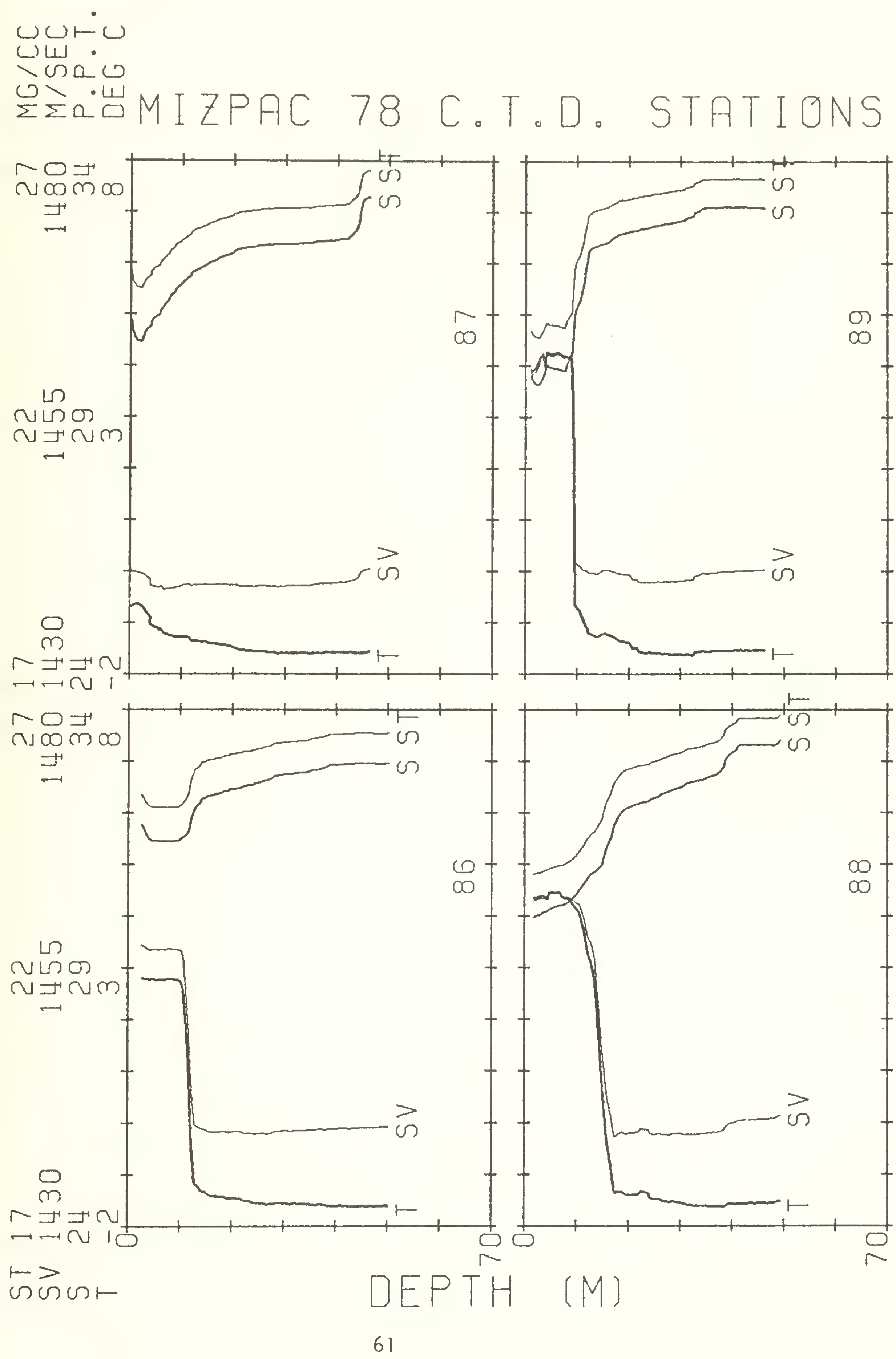

MIZPAC 78 C.T.D. STATIONS
ST MG/CC
SV M/SEC
S P.P.T.
T DEG C
17 22 27
1430 1455 1480
24 29 34
-2 3 8
S ST
S
SV
T
76
77
T SV S ST
75
76
0
70
DEPTH (M)

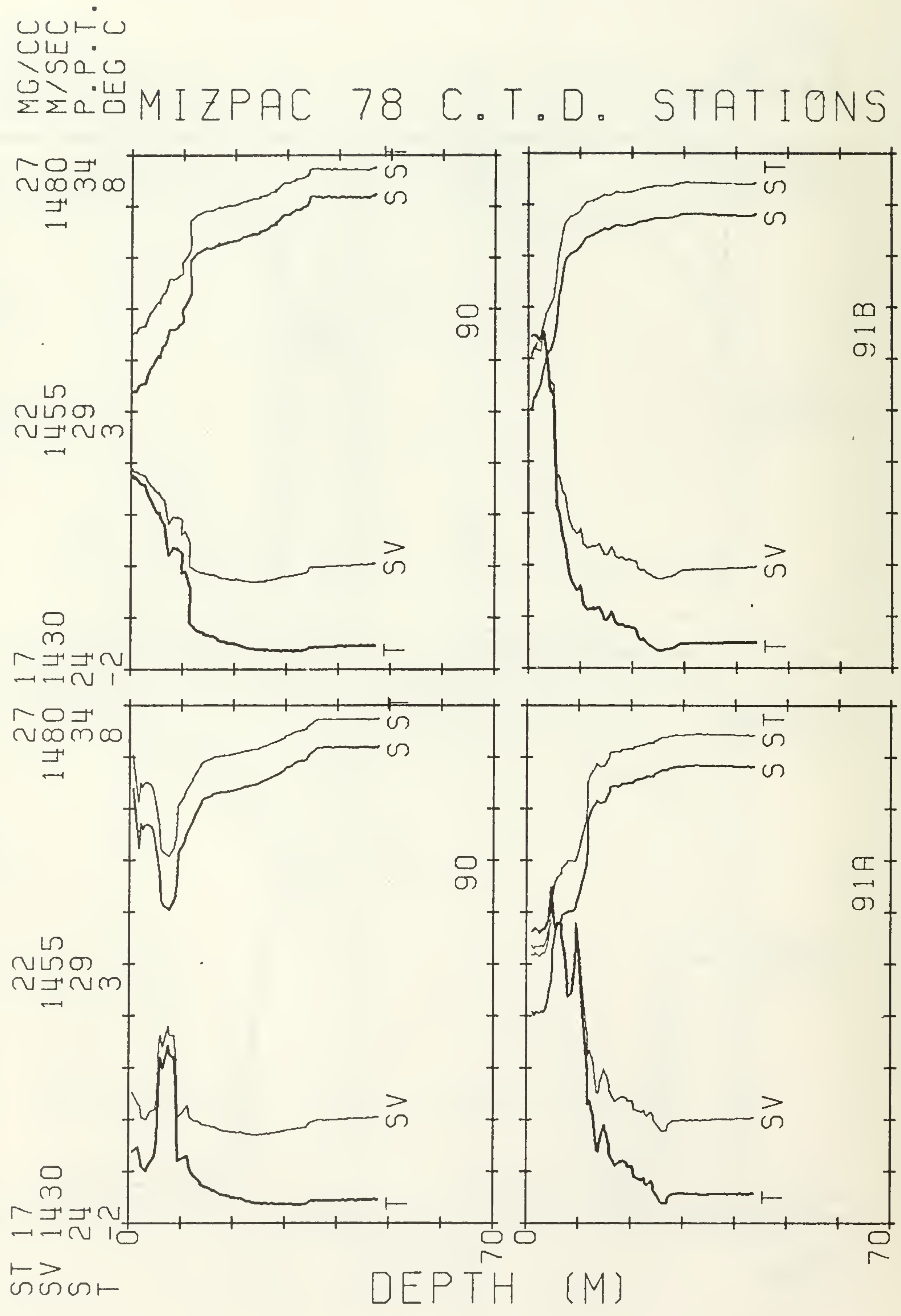


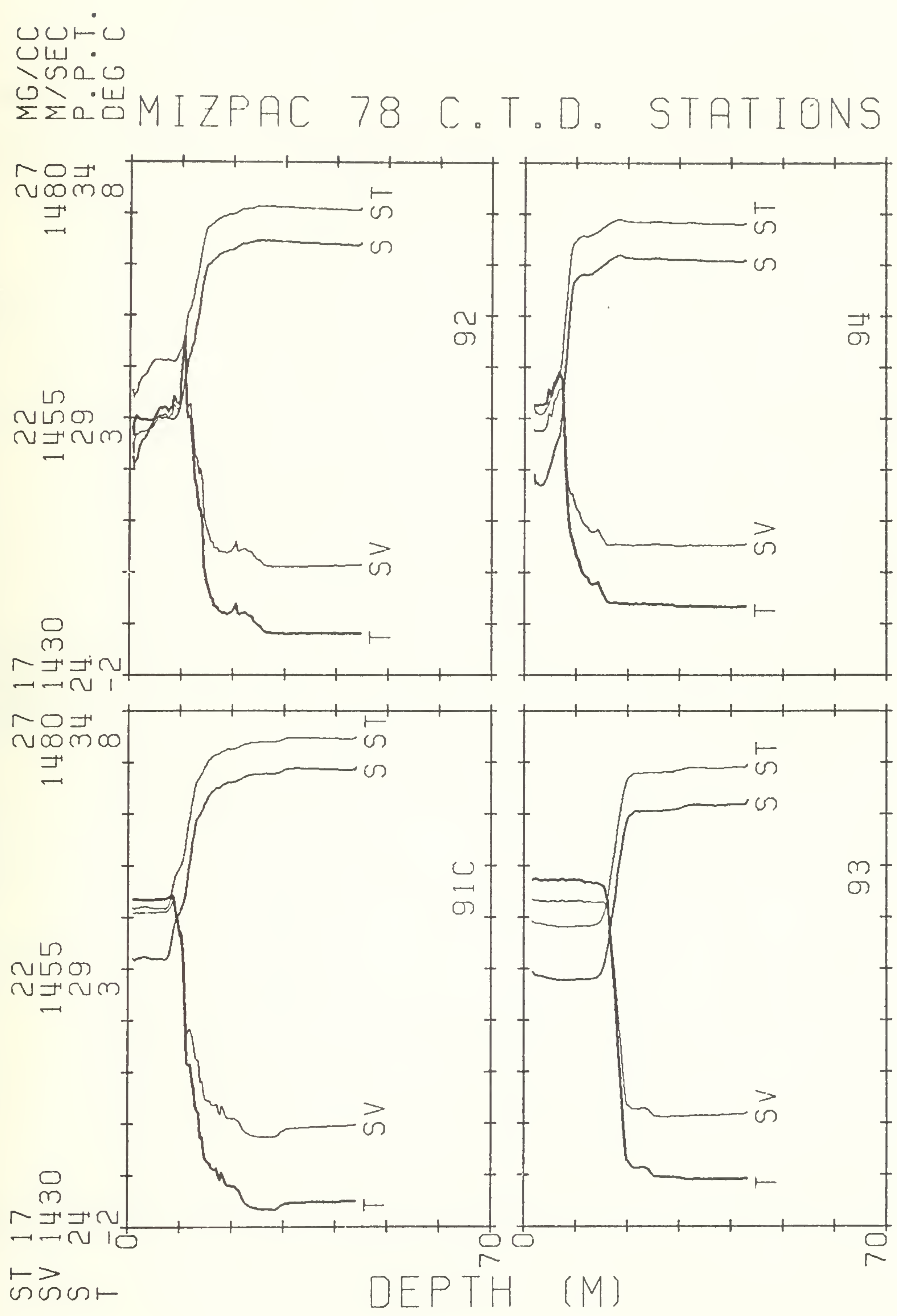
MIZPAC 78 CTD STATIONS
ST SV S T
27 1480 34 8 MG/CC M/SEC P.P.T. DEG C
22 1455 29 3
17 1430 24 -2
SST
SV
T
77
S ST
S
SV
T
76
0
50
100
DEPTH (M)

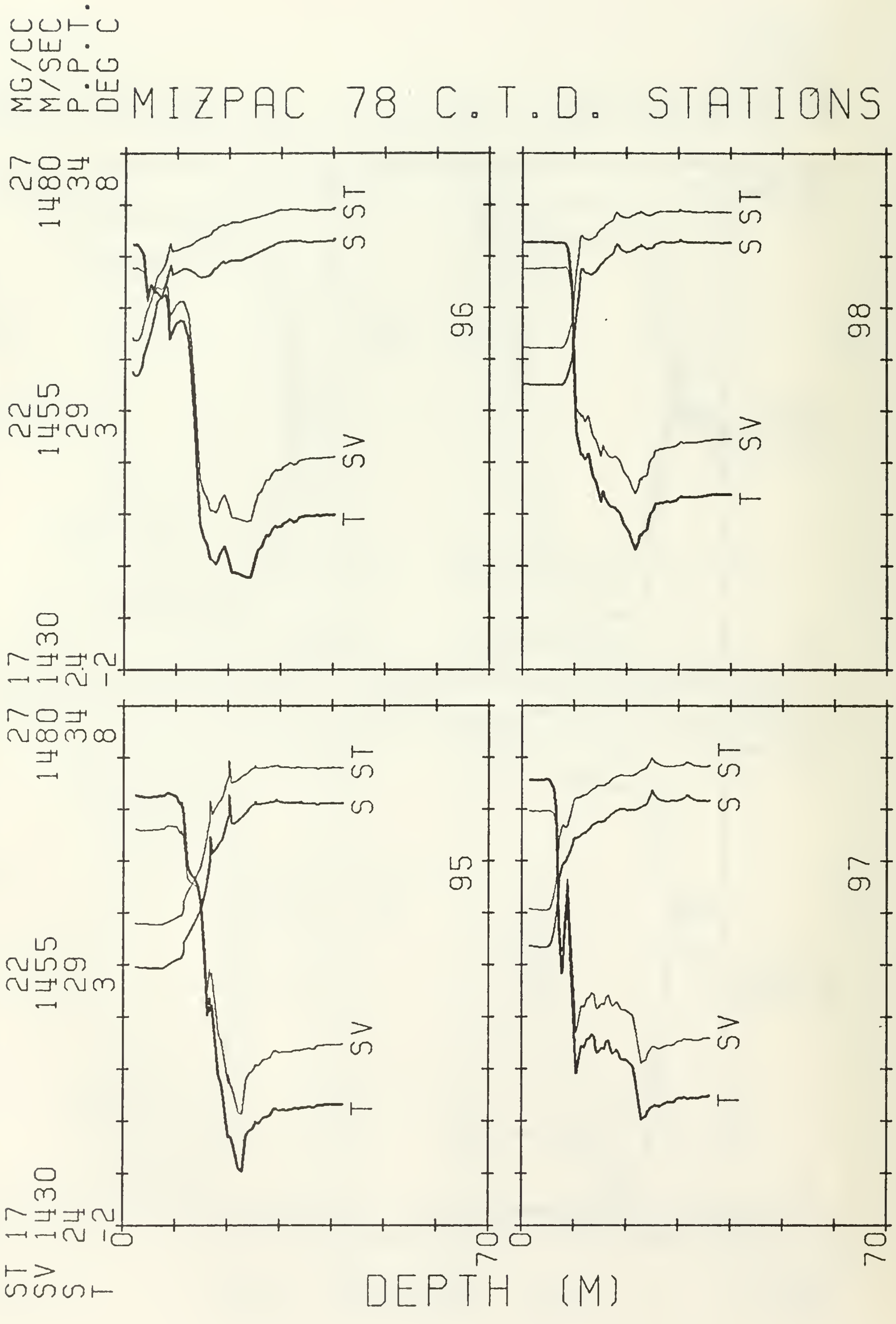

MIZPAC 78 C.T.D. STATIONS
ST 17 22 27 MG/CC
SV 1430 1455 1480 M/SEC
S 24 29 34 P.P.T.
T -2 3 8 DEG C
DEPTH (M)
0
70
T SV S ST
78
79
80
81

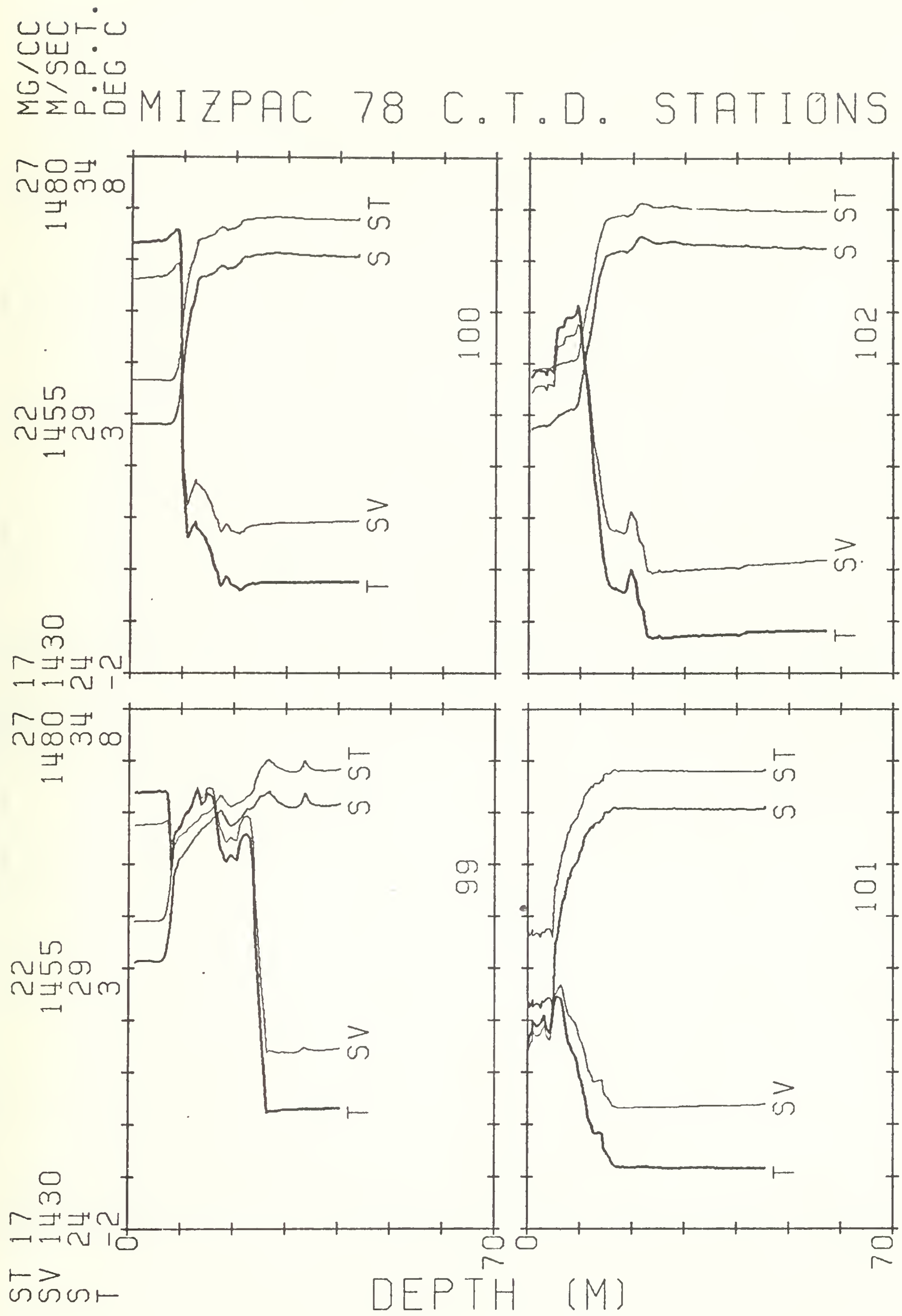

MIZPAC 78 C.T.D. STATIONS
MG/CC
M/SEC
P.P.T.
DEG C
ST 17 22 27
SV 1430 1455 1480
S 24 29 34
T -2 3 8
83
85
82
84
S ST
S
SV
T
0
70
DEPTH (M)


MIZPAC 78 C.T.D. STATIONS
MG/CC
M/SEC
P.P.T.
DEG C
ST 17 22 27
SV 1430 1455 1480
S 24 29 34
T -2 3 8
87
89
86
88
S S T
SV
T
0
70
DEPTH (M)

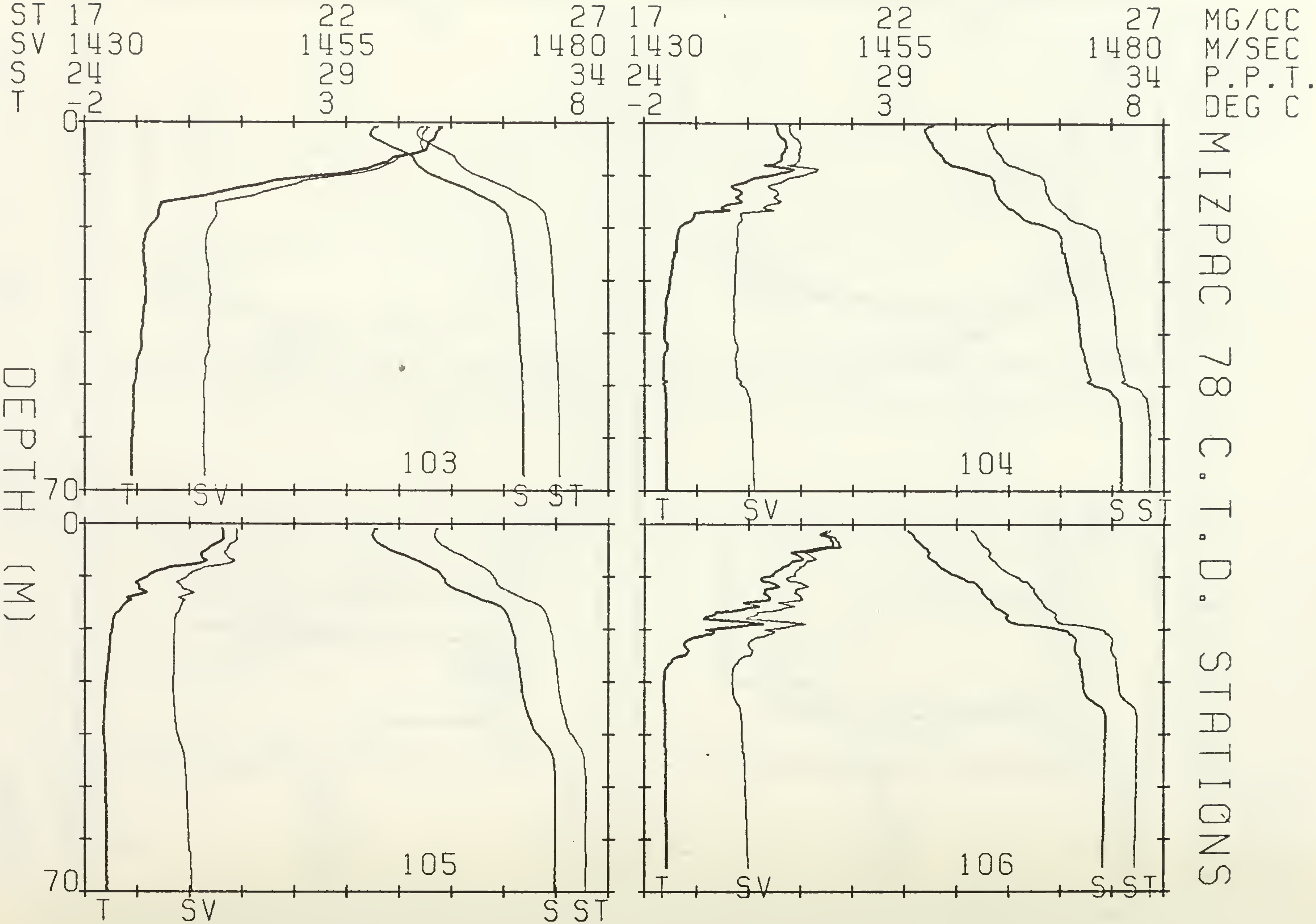

MIZPAC 78 C.T.D. STATIONS
MG/CC
M/SEC
P.P.T.
DEG C
ST 17 22 27
SV 1430 1455 1480
S 24 29 34
T -2 3 8
90
91B
91A
S ST
SV
T
0
70
DEPTH (M)

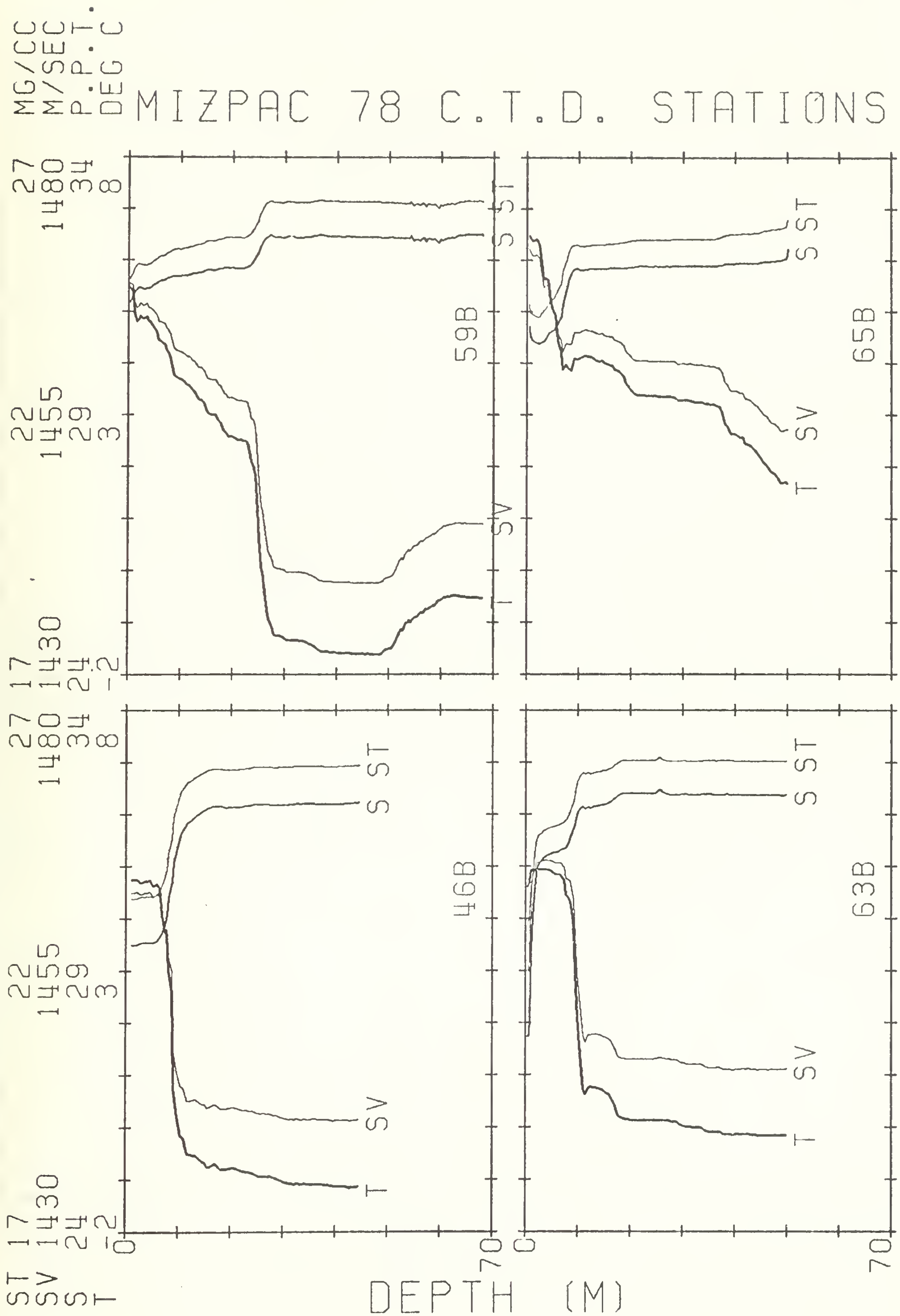

MIZPAC 78 C.T.D. STATIONS
MG/CC
M/SEC
P.P.T.
DEG C
ST 17 22 27
SV 1430 1455 1480
S 24 29 34
T -2 3 8
DEPTH (M)
0
70
92
94
91C
93
S ST
S
SV
T

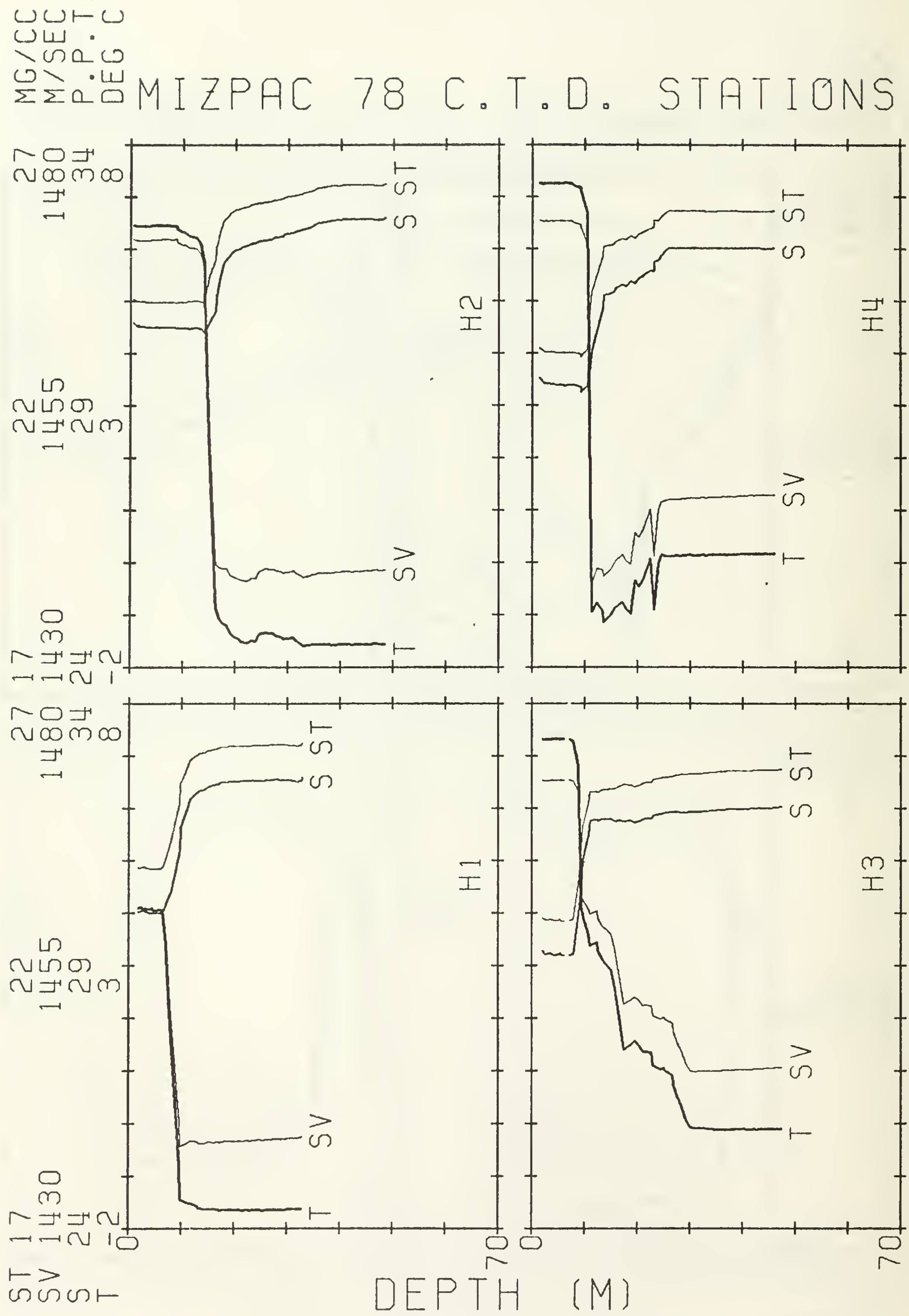

MIZPAC 78 C.T.D. STATIONS
MG/CC
M/SEC
P.P.T.
DEG C
ST SV S T
27 1480 34 8
22 1455 29 3
17 1430 24 -2
S ST
S
SV
T
95
96
97
98
0
70
DEPTH (M)

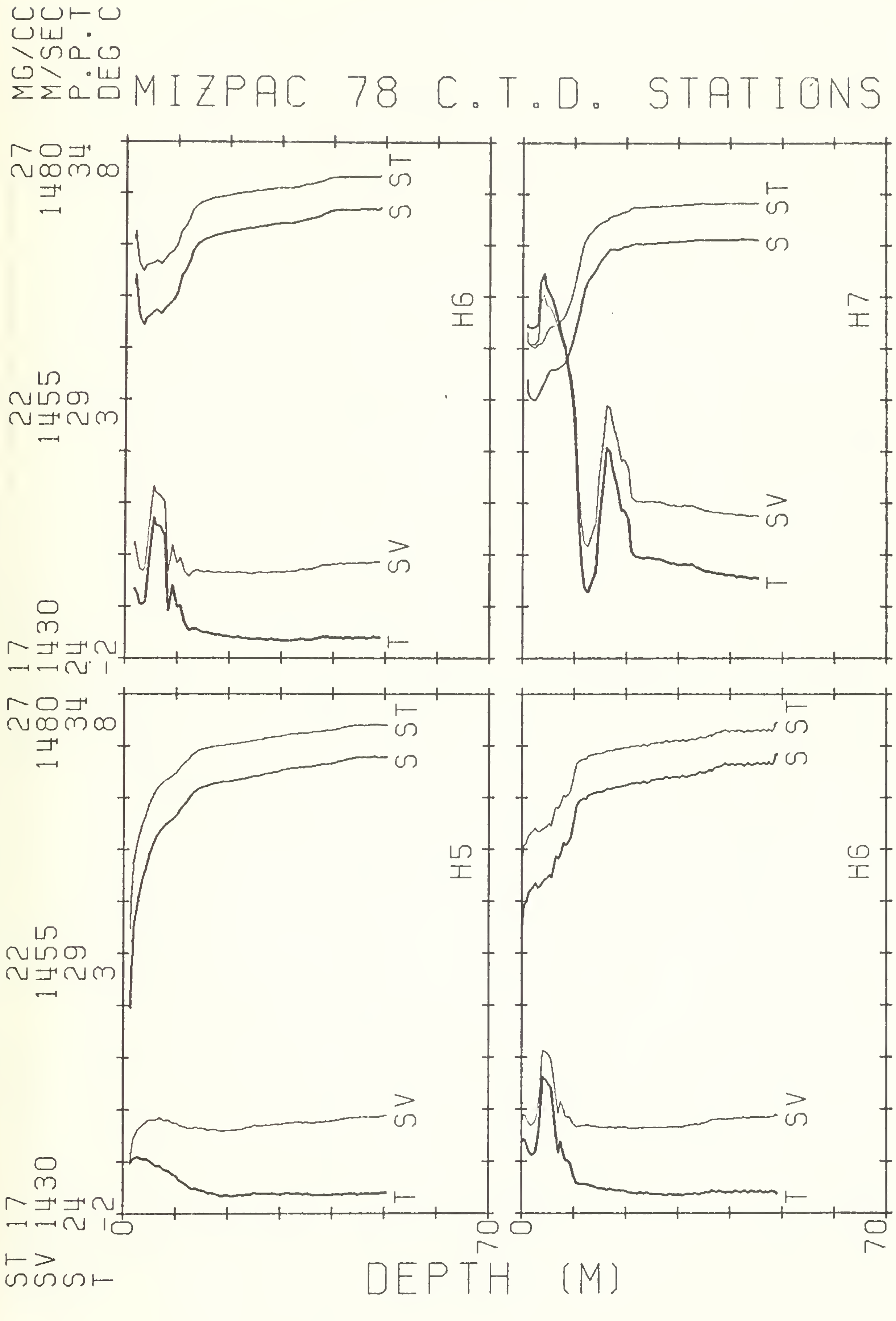


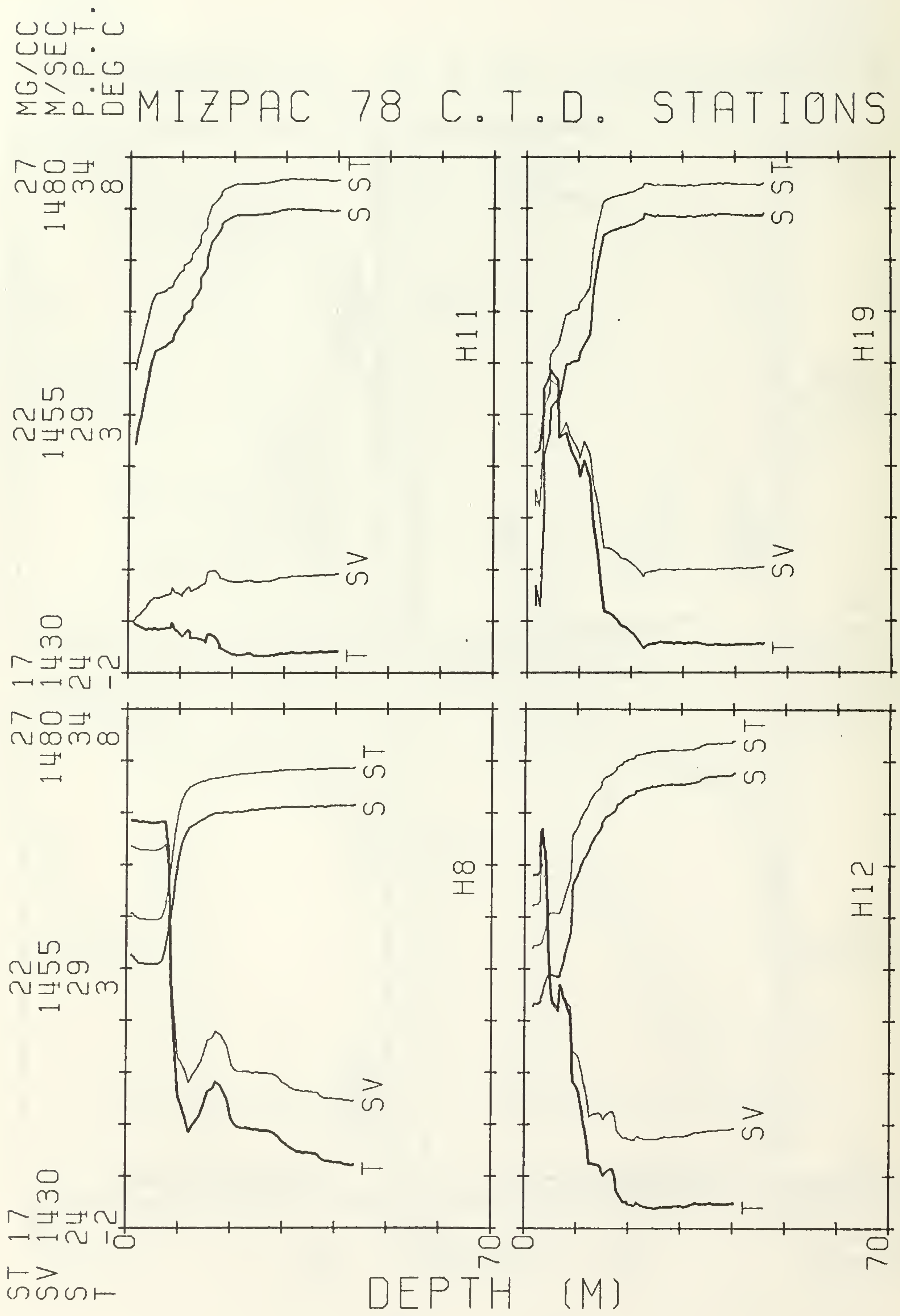
MIZPAC 78 C.T.D. STATIONS
MG/CC
M/SEC
P.P.T.
DEG C
27 1480 34 8
22 1455 29 3
17 1430 24 -2
ST
SV
S
T
100
102
99
101
S ST
S
SV
T
0
70
DEPTH (M)


MIZPAC 78 C.T.D. STATIONS
ST 17 22 27 MG/CC
SV 1430 1455 1480 M/SEC
S 24 29 34 P.P.T.
T -2 3 8 DEG C
DEPTH (M)
0
70
103
104
105
106
T
SV
S
ST

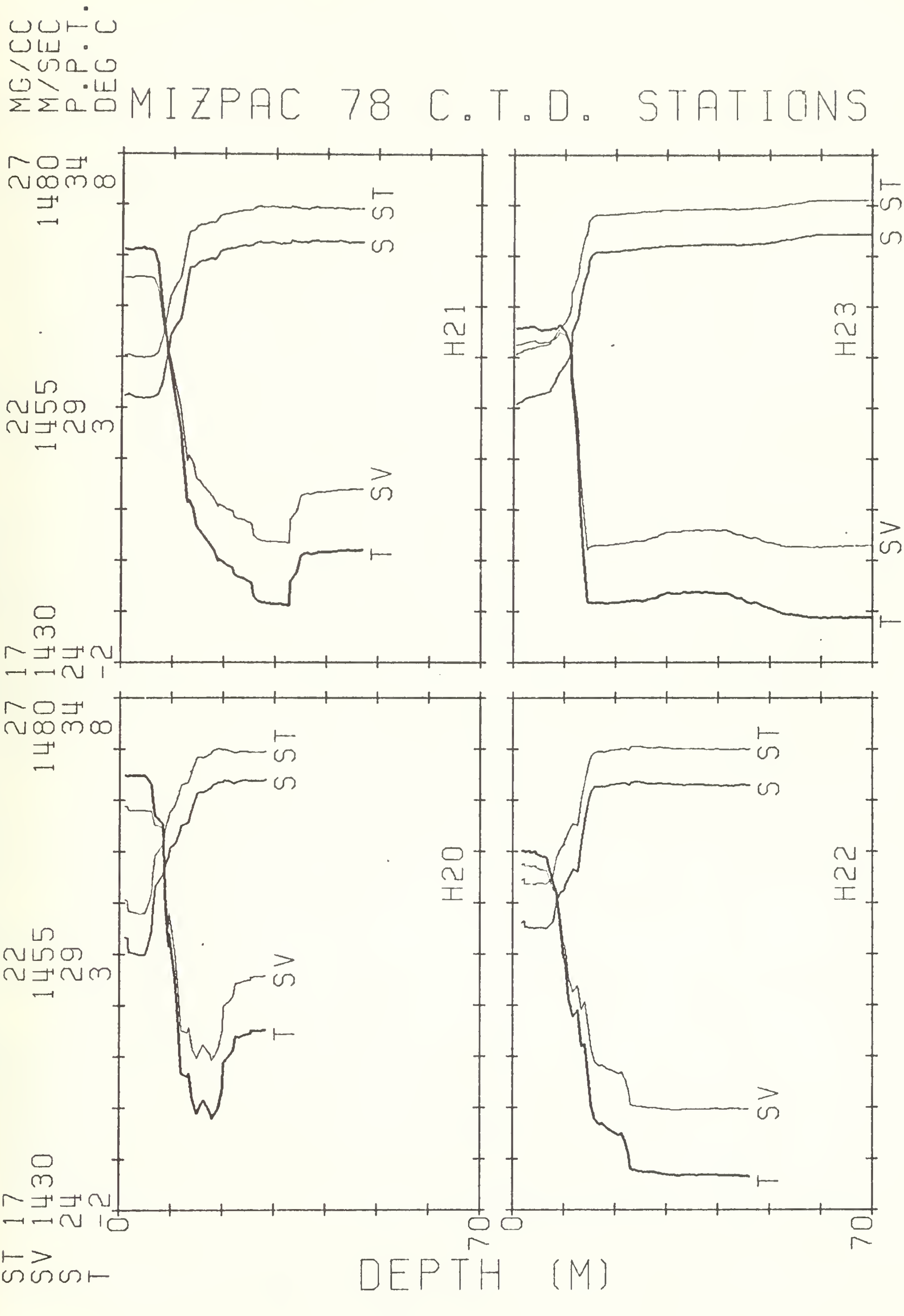

MIZPAC 78 C.T.D. STATIONS
MG/CC
M/SEC
P.P.T.
DEG C
ST SV S T
17 1430 24 -2
22 1455 29 3
27 1480 34 8
59B
65B
46B
63B
S ST
SV
T
0
70
DEPTH (M)


MIZPAC 78 C.T.D. STATIONS
ST MG/CC 17 22 27
SV M/SEC 1430 1455 1480
S P.P.T. 24 29 34
T DEG.C -2 3 8
H1
H2
H3
H4
S ST
SV
T
0
70
DEPTH (M)

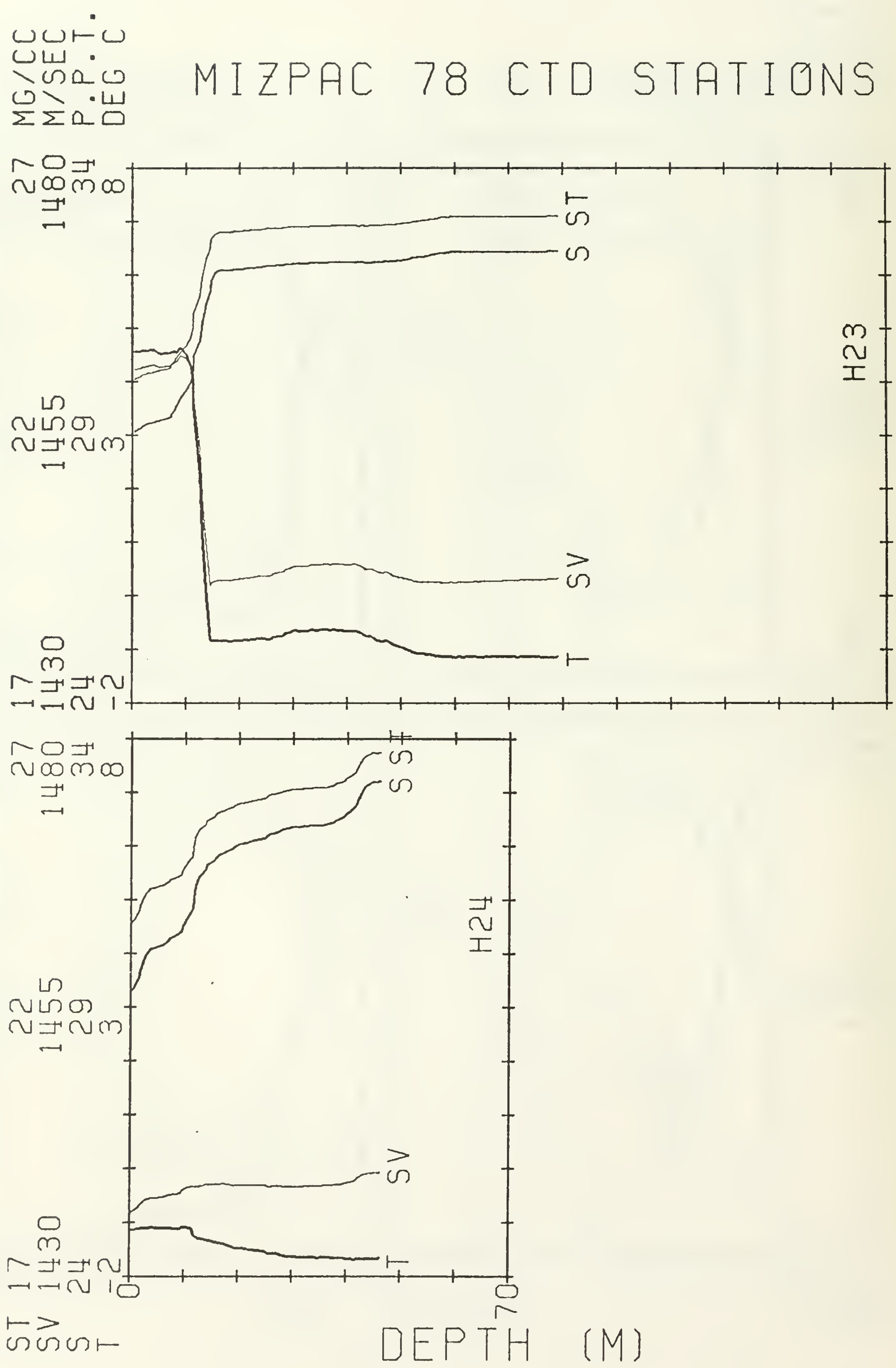

MIZPAC 78 C.T.D. STATIONS
MG/CC
M/SEC
P.P.T.
DEG C
ST SV S T
17 1430 24 -2
22 1455 29 3
27 1480 34 8
H6
H7
H5
H6
S ST
S
SV
T
0
70
DEPTH (M)



MIZPAC 78 C.T.D. STATIONS
MG/CC
M/SEC
P.P.T.
DEG C
ST SV S T
17 1430 24 -2
22 1455 29 3
27 1480 34 8
H11
H19
H8
H12
S ST
SV
T
0
70
DEPTH (M)



MIZPAC 78 C.T.D. STATIONS
MG/CC
M/SEC
P.P.T.
DEG C
ST
SV
S
T
DEPTH (M)
H20
H21
H22
H23


MIZPAC 78 CTD STATIONS
27 MG/CC
1480 M/SEC
34 P.P.T.
8 DEG.C
22
1455
29
3
17
1430
24
-2
ST
SV
S
T
0
70
DEPTH (M)
S ST
SV
T
H23
H24

DISTRIBUTION LIST

ADDRESSEE	NO. OF COPIES
Director Applied Physics Laboratory University of Washington 1013 Northeast 40th Street Seattle, Washington 98195	
Mr. Robert E. Francois	1
Mr. E. A. Pence	1
Mr. G. R. Garrison	1
Library	1
University of Washington Department of Oceanography Seattle, Washington 98195	
Fisheries-Oceanography Library	1
L. K. Coachman	1
Director Arctic Submarine Laboratory Code 54, Building 371 Naval Ocean Systems Center San Diego, CA 92152	25
Superintendent Naval Postgraduate School Monterey, California 93940	
Library	2
Dr. R. G. Paquette	5
Dr. R. H. Bourke	5
Polar Research Laboratory, Inc. 123 Santa Barbara Street Santa Barbara, California 93101	2
Director Naval Arctic Research Laboratory Barrow, Alaska 99723	
Library	1
Chief of Naval Operations Department of the Navy Washington, D. C. 20350	
NOP-02	1
NOP-22	1
NOP-946D2	1
NOP-095	1
NOP-098	1

DISTRIBUTION LIST

ADDRESSEE	NO. OF COPIES
Commander Submarine Squadron THREE Fleet Station Post Office San Diego, California 92132	1
Commander Submarine Group FIVE Fleet Station Post Office San Diego, California 92132	1
Director Marine Physical Laboratory Scripps Institute of Oceanography San Diego, California 92132	1
Commanding Officer Naval Intelligence Support Center 4301 Suitland Road Washington, D. C. 20390	1
Commander Naval Electronics Systems Command Naval Electronics Systems Command Headquarters Department of the Navy Washington, D. C. 20360	1
NESC 03	1
PME 124	1
Director Woods Hole Oceanographic Institution Woods Hole, Massachusetts 02543	1
Commanding Officer Naval Coastal Systems Laboratory Panama City, Florida 32401	1
Commanding Officer Naval Submarine School Box 700, Naval Submarine Base, New London Groton, Connecticut 06340	1
Assistant Secretary of the Navy (Research and Development) Department of the Navy Washington, D. C. 20350	2

DISTRIBUTION LIST

ADDRESSEE	NO. OF COPIES
Director of Defense Research and Engineering Office of Assistant Director (Ocean Control) The Pentagon Washington, D. C. 20301	1
Commander, Naval Sea Systems Command Naval Sea Systems Command Headquarters Department of the Navy Washington, S. C. 20362	4
Chief of Naval Research Department of the Navy 800 North Quincy Street Arlington, Virginia 22217	1
Code 102-OS	1
Code 220	1
Code 461	1
Project Manager Anti-Submarine Warfare Systems Project Office (PM4) Department of the Navy Washington, D. C. 20360	1
Commanding Officer Naval Underwater Systems Center Newport, Rhode Island 02840	1
Commander Naval Air Systems Command Headquarters Department of the Navy Washington, D. C. 20361	2
Commander Naval Oceanographic Office Washington, D. C. 20373 Attention: Library Code 3330	2
Director, Defense Supply Agency Defense Documentation Center Cameron Station Alexandria, Virginia 22314	2
Director Advanced Research Project Agency 1400 Wilson Boulevard Arlington, Virginia 22209	1

DISTRIBUTION LIST

ADDRESSEE	NO. OF COPIES
Commander Naval Weapons Center China Lake, California 93555 Attention: Library	1
Commander Naval Electronics Laboratory Center 271 Catalina Boulevard San Diego, California 92152 Attention: Library	1
Director Naval Research Laboratoy Washington, D. C. 20375 Attention: Technical Information Division	3
Director Ordnance Research Laboratory Pennsylvania State University State College, Pennsylvania 16801	1
Commander Submarine Force, U. S. Atlantic Fleet Norfolk, Virginia 23511	2
Commander Submarine Force, U. S. Pacific Fleet N-21 Pearl Harbor, HI 96860	1
Commander Naval Air Development Center Warminster, Pennsylvania 18974	1
Commander Naval Ship Research and Development Center Bethesda, Maryland 20084	1
Chief of Naval Material Department of the Navy Washington, D. C. 20360	
NMAT 03	2
NMAT 034	1
NMAT 0345	1

DISTRIBUTION LIST

ADDRESSEE	NO. OF COPIES
Commander SECOND Fleet Fleet Post Office New York, N. Y. 09501	1
Commander THIRD Fleet Fleet Post Office San Francisco, California 96601	1
Commander Naval Surface Weapons Center White Oak Silver Spring, Maryland 20910	
Mr. M. M. Kleinerman	1
Library	1
Officer-in-Charge New London Laboratory Naval Underwater Systems Center New London, Connecticut 06320	1
Commander Submarine Development Group TWO Box 70 Naval Submarine Base, New London Groton, Connecticut 06340	1
Oceanographer of the Navy Naval Oceanography Division (OP 952) Naval Department Washington, D.C. 20350	1
Commandant U.S. Coast Guard Headquarters 400 Seventh Street, S. W. Washington, D.C. 20590	2
Commander Pacific Area, U. S. Coast Guard 630 Sansome Street San Francisco, California 94126	1
Commander Atlantic Area, U. S. Coast Guard Governors Island New York, N.Y. 10004	1
USA CRREL Hanover, NH 03755	
Library	1
Defense Documentation Center Cameron Station Alexandria, Virginia 22314	2